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CONTENTS.

	PAGE
Editorial	61
The Government Telegraph Agitation	64
Electrical Engineers of the Day—XXVIII. Reginald A. Fessenden	64
The Waterside Station of the New York Edison Company—II	65
Electrical Equipment of the Manhattan Elevated Railway—I	76
Complete Commercial Test of Polyphase Induction Motors Using One Wattmeter and One Voltmeter. By A. S. McAllister	78
Electric Gas Lamps and Gas Electrical Resistance Phenomena. By Peter Cooper Hewitt	80
Illumination Discussion Before the Institute	82
The Present Status of the Question of a Standard of Light. By Clayton H. Sharp	83
American Institute of Electrical Engineers	84
The Everett-Moore Trolley System	85
Electro-Chemical Patents of the Week	86
New Telephone Patents	87
General Greely on Wireless Telegraphy	88
Automatically Closing Bulkhead Doors	89
Mr. Carnegie's National Institute	89
The Grounding of High Potential Circuits	89
Current News and Notes	89
LETTERS TO THE EDITORS:	
Theory of the Edison Nickel-Iron Cell. By Woolsey McA. Johnson	90
Safety of Consumers and Grounding of Secondaries. By Chas. T. Dashiell	91
Conditions of Money Order Telephony. By David J. Monosmith	91
A 19,000-Volt Shock. By J. R. Cravath	91
Digest of Current Electrical Literature	92
New Books	96
Westinghouse Standard Transformers	97
Electrically-driven Boring Machine	98
DEPARTMENTS:	
Financial Intelligence	99
Commercial Intelligence	100
General News	102
Trade Notes	105
Record of Electrical Patents	106

OUR INDEX.

A good deal of trouble is always taken in the preparation of the Index to each volume of ELECTRICAL WORLD AND ENGINEER, but on the Index to Vol. XXXVIII. unusual pains have been bestowed, with a closer attempt at classification. The growing magnitude and variety of electrical interests is well brought out by such a survey of the contents of this journal, and looking over it there seems to be hardly any topic of importance in regard to human affairs that is not in some way affected by electricity. We are inclined to believe that many of our readers refresh their memories with the Index, or are notified of things interesting to them by it, as there is always a call for back numbers after its appearance—a call which we are often unable to supply.

SMOKE IN THE TUNNEL.

A terrible accident occurred on Wednesday morning in the Park Avenue tunnel, this city, of the New York Central Railroad, when 15 people were killed outright and some two score injured by a collision, one fast train running into the rear car of another standing in the tunnel. As we go to press, it looks as though signals were working perfectly, but that in the blur of smoke and steam the engineer at fault did not see that the lights were set against him. Be this as it may, there will undoubtedly be a great public renewal of the outcry for the abolition of steam traction in the tunnel and the adoption of electricity. The problem of the change is a serious one, but there is absolutely no good reason why the change should not be made. Electricity brings in its own dangers, as illustrated by the recent disastrous blowing of a fuse in a tunnel on the Liverpool Elevated, but it cannot be denied that, broadly and largely considered, electric locomotion for the tunnel is feasible and will redeem it from its present low estate. We are glad to believe that the New York Central is already actively planning that way. This awful disaster can but stimulate its exertions.

TEST OF POLYPHASE MOTORS.

The article by Mr. McAllister in this number is interesting as indicating what may be computed from the use of a single wattmeter in connection with a polyphase induction motor, supplied from constant-potential mains. The complete test of such a motor is scheduled upon the basis of the primary resistance between any pair of motor terminals, and also upon the secondary resistance, reduced to the primary circuit, from observations made with the secondary element locked. The method cannot pretend to a high degree of accuracy, for it assumes uniform voltages in the different polyphase circuits, and it also ignores load losses in the motor, which are sometimes considerable, owing to variations in the distribution of magnetic flux under variations of load. But within these limitations the analysis is a straightforward calculation, based on the readings of a single wattmeter, and of a single voltmeter.

The deduction of more particular interest is the fact that purely mechanical phenomena can often be measured with a greater degree of precision and convenience by electrical instruments than by the mechanical instruments that would otherwise be necessary. For example, the slip of a large induction motor is very difficult to measure accurately by a speed counter. The amount of slip under full load in a large induction motor is often only about 2 per cent of the synchronous speed, and a very small error in the observation may introduce a large error into the computed slip. But assuming that the secondary is the revolving element of the motor, it is well known that

the slip is the ratio of the secondary copper loss to the secondary-circuit power, just as the percentage drop in speed in a direct-current motor at constant excitation is the ratio of the armature copper loss to the armature power. Since the secondary power and the secondary copper loss are each capable of being computed, their ratio—the slip—can be deduced with much less probable error than the ordinary mechanical method of observing slip will admit of, even allowing for the unknown load losses.

Stroboscopic methods are, however, in use by which the slip of an induction motor can be measured by optically controlled mechanical means with a high degree of accuracy. Thus the Braun cathode-ray tube has recently been applied with apparent success to the accurate measurement of induction motor slips. The torque of an induction motor is another mechanical quantity that is capable of being computed from the secondary power, and the synchronous speed, being the ratio of these two quantities, just as in the direct-current motor at constant excitation, the torque is calculable, as the ratio of the total armature power to the synchronous speed. While, therefore, the analysis given in the article may be useful in many instances where only a wattmeter and voltmeter are at hand, the most reliable method of testing an induction motor is to couple it to a suitable direct-current motor and measure the output with the aid of instruments in the direct-current circuit, while measuring the input by an alternating wattmeter or wattmeters.

ELECTRICITY AND LIFE.

The daily press has recently been paying considerable attention to the theories of Dr. A. F. Matthews, of Chicago University, upon the relation of electricity to nerve action. That there is a close connection between the two sets of phenomena has been evident ever since the time of Galvani, but just what that relation is has never yet been cleared up. All that could be said until recently was that an electric action seems to accompany every nervous action, and that the one action cannot take place without the other. Dr. Matthews' theory, as briefly outlined in the *New York Sun*, endeavors to supply the connecting link between the electric phenomena, on the one hand, and the chemical phenomena of the nerve on the other, by means of what is virtually an electro-chemical explanation. Nerves are stated to contain an active substance which is essentially positive in its electrification. Negative electric ions entering the nerve substance under electric impulse bring about a partial or local neutralization and a partial or local chemical change in the nerve substance, which change is accompanied by a nerve action or nerve stimulus. The hypothesis on its chemical side is a means of accounting for the action of alcohol and anæsthetics, while on the electrical side it is a means of accounting for electrotonus.

In so far as the hypothesis creates working theories harmonizing the chemical and electrical phenomena of nerve operation, it is to be received with interest, but any physiological theory involving the ionic theory of electricity is a theory of the second degree, since the ionic theory is itself only a working hypothesis that has not yet been received as a matter of demonstration beyond the pale of doubt. Moreover, it would seem from the outline given of Dr. Matthews' theory that the ionic theory might fall without necessarily implicating the essentials of the nerve-action theory here considered, so that in a certain sense it would seem that the new theory does not necessarily postulate ions in the definite sense contemplated by the modern ionic theory. Almost any of the more recent theories of electro-chemical action would, perhaps, answer the purpose of the new hypothesis equally well.

It is only reasonable to expect that in time physiologists will discover the fundamental laws—perhaps very simple in character, but no doubt very complex in superposition—which underlie nerve action, and the objective side of consciousness. There can be no doubt that electricity takes a share in this action, because all the phenomena of life are phenomena of differentiated liquids separated by thin septa, and it would be practically impossible to assemble such a mechanism without originating electric and electro-chemical actions.

ILLUMINATION.

The meeting last week of the American Institute of Electrical Engineers brought out a great variety of interesting bits of information upon practical lighting, past, present and future. It comprised a general discussion of modern illuminants followed by a group of papers taking up special topics along the same line. Incidentally, there were some notable exhibits. The open paper by Dr. Bell was a treatment of the status of modern illuminants from the physical and physiological standpoints. The essential facts brought into prominence were the necessary limitations imposed on practical illuminants by the physiological requirements of color and intrinsic brilliancy, the importance of visual usefulness as distinguished from intensity of radiant or of the illumination, and the consequent importance of using the very brilliant modern lights in diffused and indirect lighting rather than in the common fashion. The fundamental point raised was that illumination as measured in any of the usual ways does not take account of the fact that visual usefulness depends not only on the light received but upon the intensity of the source if the latter is within the field of view, each increment in intrinsic brilliancy of the source implying lessened visual usefulness in the derived illumination. Thus one may have illumination absolutely equal in amount so far as photometric measurements go from several sources, but unless these sources are of equal intrinsic brilliancy the visual value of the light will vary widely from its photometric value. This is a very important matter, brought out strongly by a later speaker in complaining bitterly and justly of the failure of arc lights as ordinarily placed in giving a clear illumination upon the street. The difficulty of seeing across an arc light and the trouble occasioned pilots by glare have been long well known, but we do not remember before noting so sharp a distinction between physical and physiological values of illumination as Dr. Bell here drew.

Mr. Ryan's interesting paper on some of the problems of street illumination specially brought out the value of enclosed arcs of moderate power in improving the distribution of light. It would have been interesting had there been included in this investigation incandescent lamps of large candle-power, or perhaps Nernst lamps. Of course, small radiants placed rather low and near together give a much more uniform light along the streets than powerful lights more widely spaced. But how far is this affected by the certainty of getting more intense light into the eye from the arcs themselves, and in how far are the conditions modified by the less light thrown upon nearby objects? President Steinmetz very aptly called attention to the fact that the street lighting situation in town and country did not present the same conditions. With high buildings to reflect the light a useful effect was produced that did not at all exist in the open fields. There seemed to be a consensus of opinion that the rather dim light from incandescents or even from oil lamps give a more serviceable illumination, i. e., greater visual usefulness, for those riding along the streets than arc lamps do. Incidentally, Mr. Ryan showed a rather interesting new form of luminometer, based upon the old idea of visual acuteness and intended for measurements of street illumination. This instrument showed itself capable of giving remarkable results, so far at least as relative values are concerned, and should prove a useful addition to the instrumental means for testing

illumination. But neither this nor any other form of portable luminometer quite duplicates practical conditions. For in such devices the eye looks into an eye-piece or hood, and is thus shielded from entrance of extraneous light, which is the very thing that ought to be included if the effect of the glare upon the visual usefulness of the illumination is to be taken into account. We hope that Mr. Ryan will later continue his interesting experiments with this point in view, and extend them to include much less powerful distribution lights than those with which he dealt in the present paper.

The exhibit of vapor tube lamps by Mr. Peter Cooper-Hewitt was a most interesting one, the more so on account of Mr. Hewitt's modest and conservative report of his experiments. It is positively refreshing to have an experimenter in a new field deal with his work in a scientific spirit, instead of playing to the galleries. The mercury arc is certainly enormously brilliant and efficient, the figure stated being 2 to 4 cp per watt, and the light, save in some of the tubes that were intentionally allowed to flame near the electrode, was remarkably steady. If it were not for its disagreeable bluish green color, this lamp would, in our opinion, even now make for itself a considerable place in the art. Just how far the color will prove a drawback in certain classes of work out of doors, experience only can show; but for interior work the present color of the tubes is forbidding, the more so as the trouble comes from an almost entire absence of red in the spectrum rather than merely from a preponderance of blue and green. Therefore, a color screen which would bring the light to a normal color-tone would very greatly reduce its intensity. There is, of course, a possibility that added substances might give to the spectrum its lacking rays, but whether this could be done without making the lamp harder to start or to operate is to be determined. One of the interesting matters in this connection is the possible effect on color vision of a discontinuous spectrum which visually seems to be satisfactory in color. It is possible to produce colored flames which can hardly be distinguished from each other by the eye, and yet have totally different spectra. One might thus very readily get an apparently good light which would still lack entirely certain useful rays. In this case it might fail to give the true color values of modern dyes. But, on the other hand, most of these show general absorption over a good part of the spectrum rather than in well defined bands, so that a fairly well distributed illumination spectrum should not distort the color effects much save in rare instances.

A profoundly interesting incident of the meeting was Mr. Hammer's exhibition of a little tube containing the rare substance *radium*, which has been brought into much prominence of late by the investigations of Becquerel, Curie and others. A constant source of Röntgen rays so powerful that it should be carried in a lead tube to avoid danger of burns, is a bit startling to say the least, and while its visible radiation was not strong, its extraordinary properties are enough to set one thinking strenuously. In point of fact, neither radium nor its ally, the so-called polonium, can be yet considered as a chemical element in good and regular standing. Their chemical status is not fairly determined, but whether they prove to be elements in the ordinary sense or allotropic modifications of better-known substances, their behavior is truly most remarkable. There are, in fact, indications that the radio-activity that characterizes them extends in a minor degree to a considerable number of other substances, but it is only fair to say that in many instances the experimentation on the subject is so difficult that consistent results are hard to obtain. The real nature of the radiation is, of course, involved in the same mystery that surrounds the Röntgen ray. In spite of the very large and valuable body of work that has been done upon this subject, the ultimate nature of the phenomena is still very far from a satisfactory explanation, since several hypotheses meet the facts fairly well, and no one of them can be verified without involving still further hypotheses as part of the argument. But the behavior of radium opens a beautiful vista of possibilities. What would happen in the art of illumination if some one should hit upon a luminous paint 50 times as brilliant and permanent as the ordinary calcium sulphide variety? If one had only to expose the light-giving body to sunlight or bright daylight for a few hours to obtain storage of energy for the evening, how the electrical arts would get shaken up! And yet such a discovery is far less improbable than some that have actually been made—like Moissan's diamonds, let us say. But diamonds are no cheaper yet, and do not sparkle galore on every fair bosom.

PHOTOMETRIC VALUES OF ARC LAMPS.

The second Progress Report of the Committee of the National Electric Light Association for investigating the photometric properties of arc lamps, an abstract of which appeared some months ago in these columns, has recently been published in full by the Association, and contains much interesting matter. These results seem to be the first published concerning the spherical candle-power of arc lamps in continued service, and the first to show curves connecting the mean spherical candle-power of arc lamps, plotted in reference to their carbon lifetime. The characteristic life-intensity curve of an alternating-current arc lamp differs markedly from the corresponding curve of an alternating-current incandescent lamp. The latter may be roughly described as consisting of a hill-section with a sharp peak of maximum candle-power, about 75 hours from the start, and with a short straight-line ascent to the peak from the beginning, and a steady straight-line descent from the peak towards the end. The arc-lamp curve is a wavy line, or, at least, only a poor attempt at a straight line, with a slight general descent from the beginning towards the end. The descent is apparently due to the discoloration of the inner globe, and the absorption of light in this discoloration film. The minor fluctuations are apparently due to changes in the positions of the arc, following the consumption.

A general conclusion to which the report points is that the light output of a pair of carbons in the alternating-current, constant-potential arc lamp does not depend so much upon the lifetime of the carbons as upon the efficiency of the arc or of the lamp. If a given current strength or a given real power in the lamp produced the same amount of light, with all the ordinary brands of carbon, then the light output for a given pair of carbons would be simply in proportion to the duration of life, or working lifetime of the carbons. These tests show, however, that while the lifetime of the carbon has an appreciable effect, the efficiency has a still greater effect. The efficiency, with a given lamp in a given state of adjustment, depends in some way upon the quality of the carbons, since the same current strength will produce a greater length of arc with some carbons than with others, and the light emitted is a function of this arc-length at constant current.

The report is a very valuable and creditable record. It is, however, a pity to see so important a piece of literature perpetuating the error in terminology appearing on page 38, where it is stated that "the efficiency" of a lamp is "1.78 watts per mean spherical Hefner unit." The fact that such errors in terminology are common, is no adequate defense. The quantity thus stated of watts per unit of luminous intensity is an inefficiency, not an efficiency, in the same way that nothing in the world can make "two hours per mile" a velocity. "Two hours per mile" must be a slowness, whereas "one-half of a mile per hour" is a velocity. Such inaccuracies may be excusable in the multitude; but not in the reports of technical committees, which form the reference literature of students.

The Government Telegraph Agitation.

It is evident from what is transpiring that the seat of the agitation for government telegraphs is in Washington and not in New York. But nothing has yet come to light connecting the administration with it in any way. Senator Mason is quoted as saying that at the first meeting of the committee on post offices ,of which he is chairman, he will call up for consideration the proposition for the government purchase of the telegraph lines. The Senator has not yet prepared any bill on the subject, but he has been gathering information. Some of his figures are as follows: The net earnings of the Western Union Telegraph Company for the year ending June 30, 1901, were $6,685,-248. Deducting from this the interest on bonds and the amount applied to the sinking fund leaves a net sum applicable to dividends of $5,729,088. Similar figures for the Postal Telegraph Company indicate a net sum applicable to dividends of $2,300,000, or a total for the two companies of $8,029,088. The present valuation of the two companies is $171,400,000, divided as follows: Western Union stock, $92,000,000; leased lines, $11,000,000; bonds, $22,000,000. Postal stock, $24,000,000; bonds, $22,000,000. If the United States Government were authorized to buy the telegraph companies, giving to the stockholders a 2 per cent bond, the results would be as follows: Net earnings as above, $8,029,088; interest on $171,400,000 bonds at 2 per cent, $3,428,000, leaving a surplus of $4,601,088. This surplus at compound interest at 2 per cent would, in about 25 years, produce the price paid for the telegraph property, and the United States Government would then have free of charge the most valuable telegraph system in the world. He does not doubt that the cable companies would make an equally good showing.

Senator Hale, of Maine, chairman of the naval affairs committee of the Senate, has again introduced and had referred to his committee his bill providing for the construction and laying by the Government of the Pacific cable to connect the United States with the Philippines.

Electrical Engineers of the Day—XXVIII.

REGINALD A. FESSENDEN.

Professor Reginald A. Fessenden was born on Oct. 6, 1866, at Bolton, P. Q., Canada. His family left Canterbury, England, in the early part of the seventeenth century, simultaneously with the progenitor of the Maxim family in this country, and founded the town of Cambridge, Mass. His branch of the family crossed the Canadian border and settled in Bolton about 1850. Mr. Fessenden received his early education at the DeVaux Military School, of Niagara Falls, N. Y., and subsequently at the Trinity College School of Port Hope, Canada, where he remained nearly four years. He early developed a talent for mathematics, and, on leaving school at the age of 16, was appointed senior mathematical master at the Bishops College School, Lennoxville, P. Q., Canada.

In 1885, at the age of 19, he went to Bermuda as principal of the Whitney Institute on that island, and occupied this position for two years. He came to New York in 1887 and entered the employment of the Edison Machine Works, which had then recently settled in Schenectady, N. Y., as tester and inspector in laying underground Edison tubes in New York City, and assisted in laying a large quantity of underground mains in the Edison district between Twenty-third Street and Central Park. In the spring of 1888 he was sent by the Edison Machine Works on special duty to the Edison laboratory of Orange, N. J. Shortly afterwards he undertook chemical work for Mr. Edison in the laboratory, of which he was head chemist from 1889 until 1890, when he left to take a position as assistant electrician with the United States Electric Company in New York. In the same year he was married to Miss Helen Trout, a descendant of one of the first governors of Bermuda. In 1891 he joined the Stanley Laboratory Company, of Pittsfield, Mass., as chemist. In 1892 he was appointed professor of physics and electrical engineering at Purdue University, Lafayette, Ind., and the following year accepted the chair of electrical engineering at the Western University of Pennsylvania, Allegheny, Pa., which he occupied until April, 1900, when he was appointed special agent for the United States Weather Bureau to take up the subject of wireless telegraphy for that Bureau. He is at present busily engaged on this work, with headquarters at Roanoke Island, N. C.

Professor Fessenden has published in all about 70 papers on chemical, physical and electro-technical subjects. These papers have appeared mainly in these columns, in the *Physical Review, Chemical News, Nature, Science,* and the *Transactions* of the American Institute of Electrical Engineers. He is not only a theorist and mathematician, deeply interested in the more remote and recondite questions concerning the nature of electromagntism, but he is also very practical and utilitarian, and has undertaken a large amount of purely experimental work. He is also an inventor and has taken out a number of patents for improvements in applied electricity.

Prominent among his published papers are two on "The Electrostatic Theory of Cohesion," published in these columns and in *Science* in 1891-1892. In these papers electrical charges were, for the first time, quantitatively considered as specific properties of atoms, and the forces due to these charges were analyzed. This paper was a forerunner of the existing ionic theory of matter, which has since been developed by a number of prominent physicists. A formula was also deduced in the paper, connecting the electric conductivity of metals with the size of their atoms, and these values have since received experimental verification.

Another important paper was "On the Nature of the Quantity Upon Which the Nature of Electricity and Magnetism Depends," published in these columns in 1894. In this paper the consequence was first deduced, prior to the experimental discoveries of Zeeman and Lenard, that ions placed in a magnetic field must rotate and influence light passing through the medium.

In his paper "On the Nature of Electric and Magnetic Quantities," published in the *Physical Review* in January, 1900, it was deduced that either a linear relation between magnetic force and reluctance as well as a second power relation between electric force and electric resistance or vice versa; also that an experimental determination as to which of these alternatives exists is sufficient to determine the dimensions of electric and magnetic quantities in absolute measure. The linear relation between magnetic force and magnetic intensity was here first demonstrated as a necessary consequence of the theory, and it was also predicted for the first time that the capacity of a condenser varied with increasing voltage by an amount depending upon the square of the voltage, a fact which has since been announced as having been experimentally observed in Europe.

Professor Fessenden has invented a number of physical measuring instruments, which have been described from time to time in these columns, such as frequency measurers, curve-tracers, permeameters, balance thermopiles, acetylene standards of lights, etc. He has also worked out successfully various new methods of sending and receiving signals in wireless telegraphy. Professor Fessenden is a member of the American Institute of Electrical Engineers and a number of scientific bodies. Direct and earnest in all his work, he is equally direct and unassuming in his manner, and a universal favorite among those who know him.

The Waterside Station of the New York Edison Company–II.

THE GENERATING SYSTEM.

IN the first section of this description of the new Waterside plant of the New York Edison Company, a comprehensive statement was given as to the general conditions and the problems of current generation and distribution which the station is intended to dispose of satisfactorily, and some details were also entered into with regard to the main engineering features. It will have been gathered that in such a plant and such a system mere figures in itself introduces new complexities and brings itno sight a new range of difficulties. In electrical work that deals with the distribution of current, light, power, intelligence, etc., from a central source, the natural tendency and the unceasing cry is for a larger station, a larger operating room, a large exchange, but at each remove the danger grows of a more complete shut down in case of trouble and disaster. How to deal with this contingency and circumvent the peril is one of the superadded elements of the problem of giving service, and the extent with which it necessitates heavier outlays on construction realized by the public.

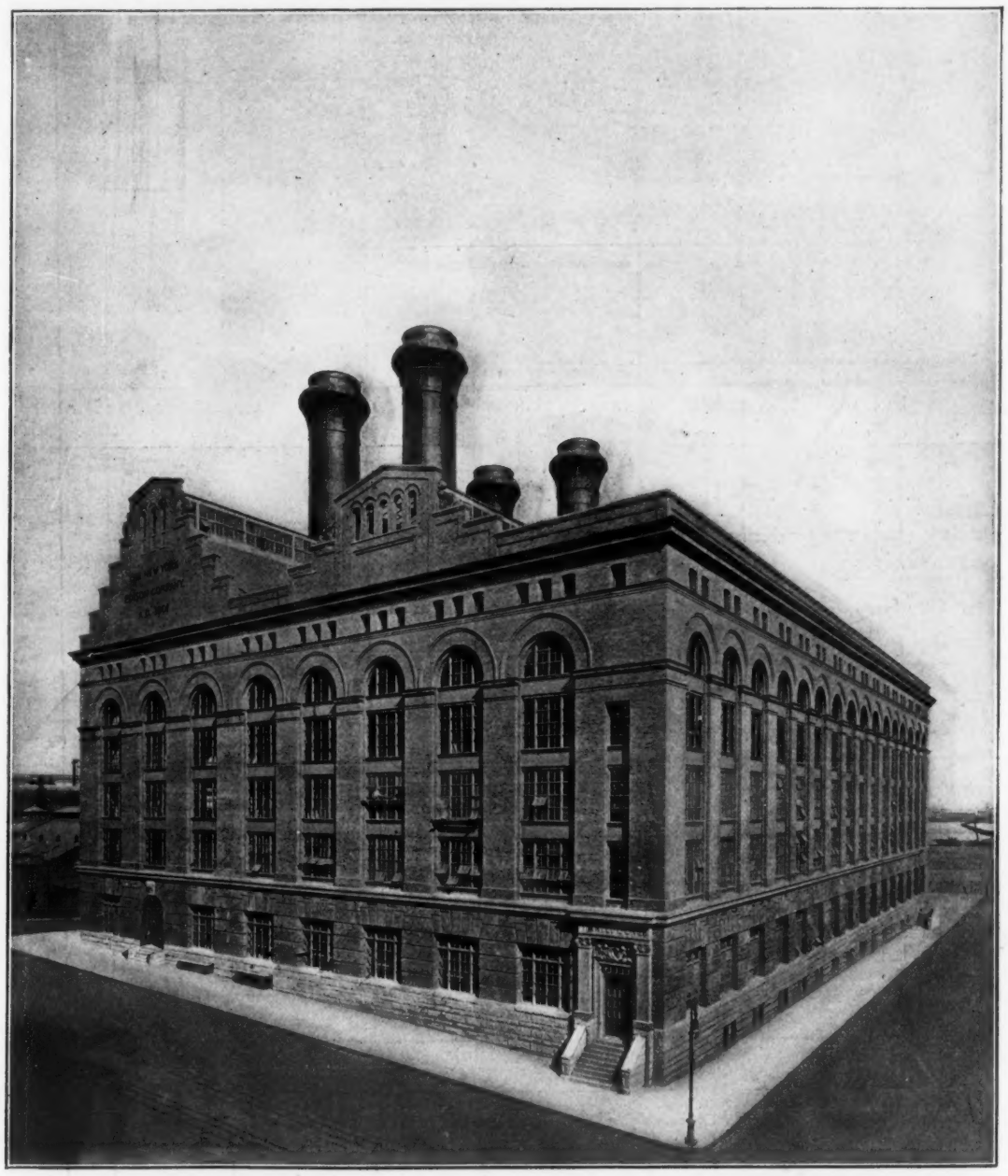


FIG. 15.—NEW WATERSIDE STATION, NEW YORK EDISON COMPANY, FROM FIRST AVENUE AND THIRTY-EIGHTH STREET, SHOWING DYNAMO ROOM, SIDE AND WEST FRONT.

Central station work of late years growing into mechanical and electrical organisms that deal with huge volumes of current liable to incessant and wide fluctuation of demand, has been peculiarly

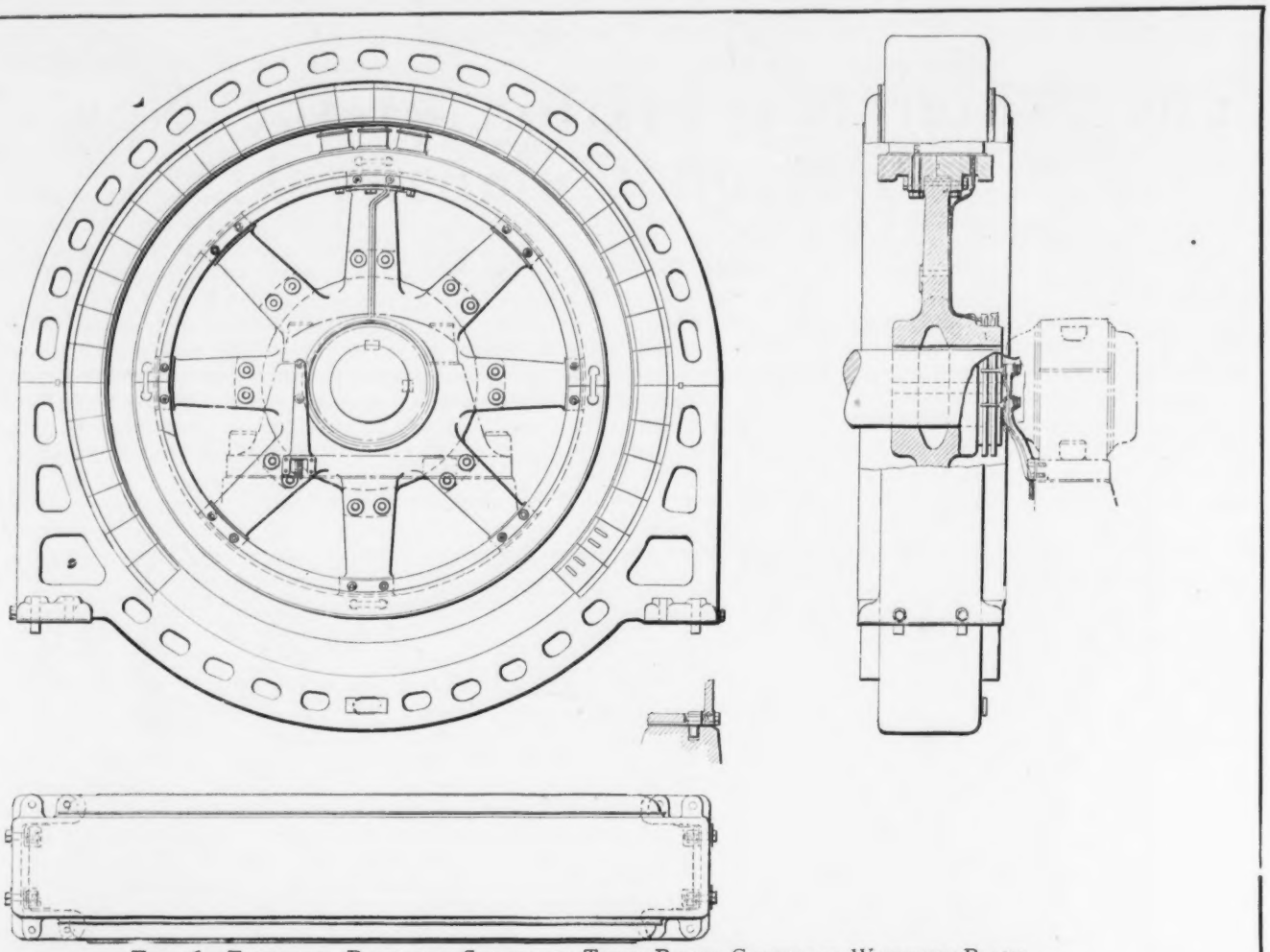


FIG. 16.—ELEVATION, PLAN AND SECTION OF THREE-PHASE GENERATOR, WATERSIDE PLANT.

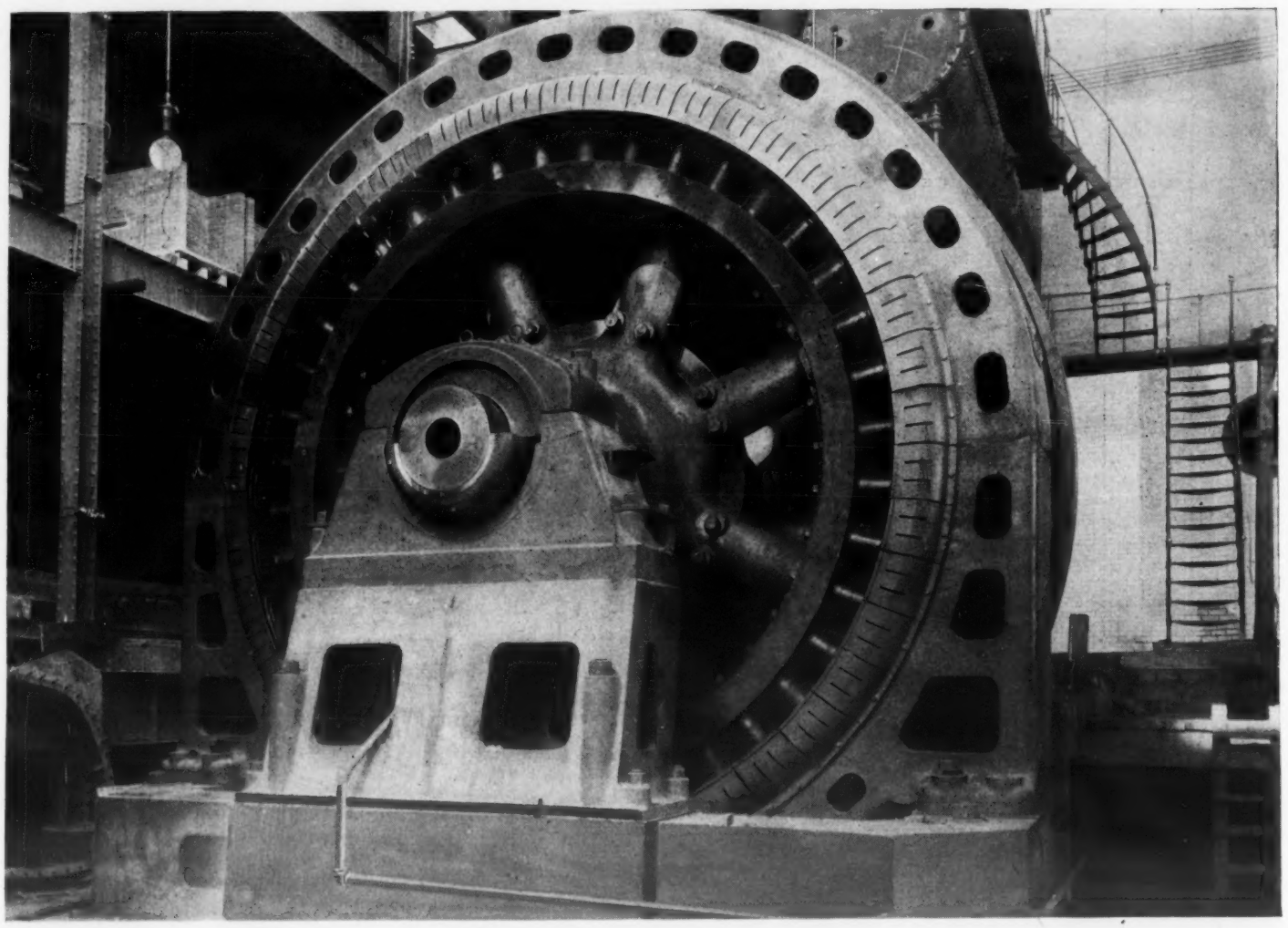


FIG. 17.—A GENERAL ELECTRIC THREE-PHASE GENERATOR, WATERSIDE PLANT.

WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.

occupied with the burden of this vital problem of avoiding interruption or shut-down. In New York City the Edison Company can certainly "point with pride" to its maintenance of service, so smooth and regular that we hesitate to discuss even thus tentatively its possible interruption; but the company in its wider, larger scope of operation has planned, as wise engineers should, to furnish every precaution for every lurking trouble, known or unknown, and has also had to evolve many novel ideas in practice to this end. We are dealing now with the power plant, but the map given in our last issue showed the extent of the area and the number of the sub-stations to be kept in constant supply and touch, looking to Waterside as the mighty heart sending out to all its pulses of current. It may not be generally known that the direct-current generated directly or transformed from alternating by the scattered rotaries of the New York Edison Company is fed by 76 stations and sub-stations at more than 200 points into one immense network of underground mains. This network is continuous, and, as will be seen by referring to the map we gave extends from the Battery on the south to 130th Street on the north, and from the Hudson to the East River. To this special feature, however, we shall return later.

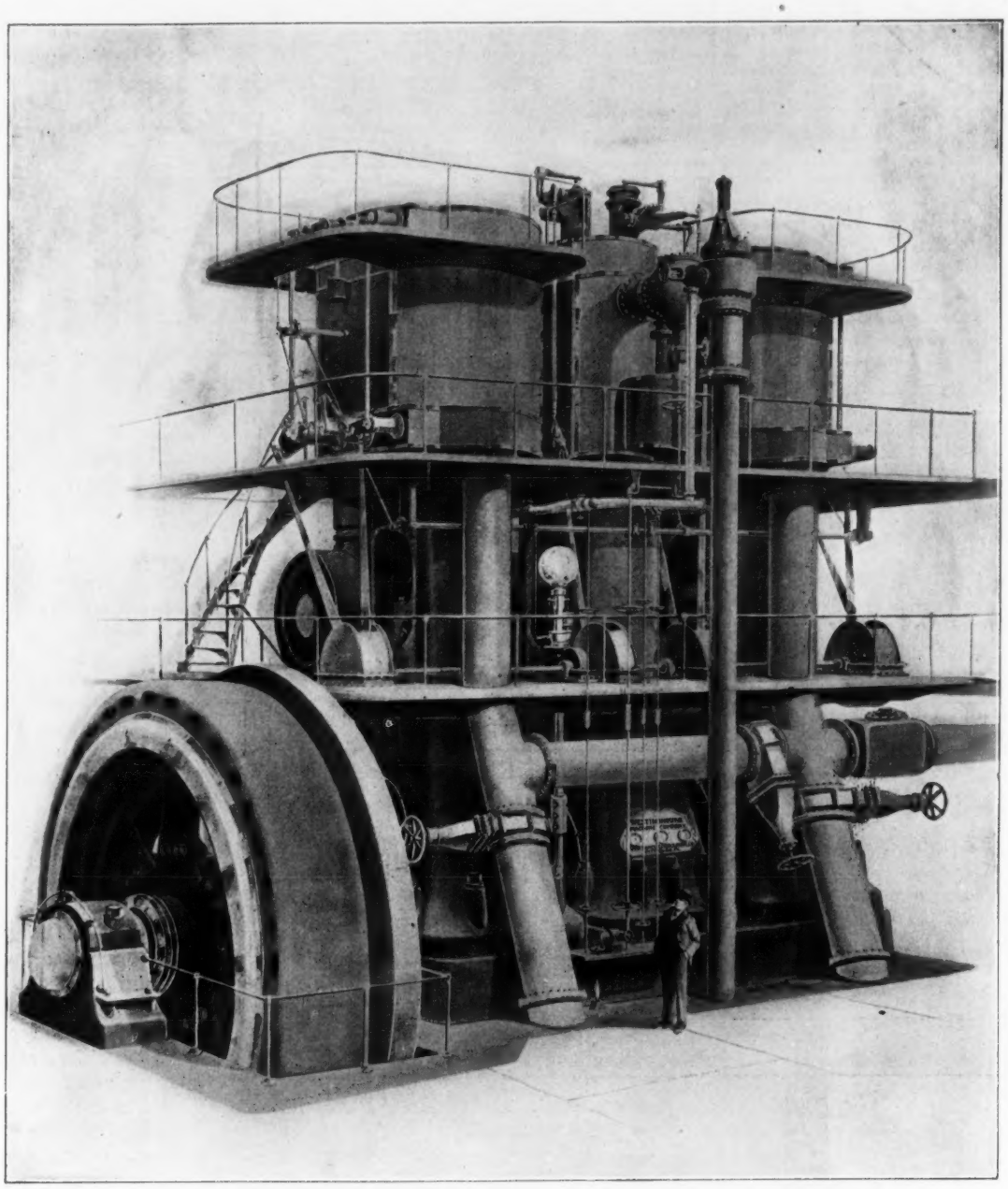


FIG. 18.—ONE OF THE 8000-HP UNITS, NEW WATERSIDE STATION, NEW YORK EDISON COMPANY.

Meantime, let us note that in the Waterside station the principal aim in planning the electrical plant was to so design it that in case of any accident, burn-out or short circuit occurring on any cable, switch or piece of apparatus, it could be confined to the place in which it originated, so that it could not communicate in any way with or cause injury to any other part of the system. The underlying idea is, so to speak, that of cellular or compartmental construction, starting out with any given generating unit, so that it and its auxiliary apparatus might fairly be considered in each case as a separate complete station. There are thus 16 central stations in one. The same idea is indeed carried out in the subways and cables connecting with the various rotary stations, each station receiving its supply by at least two cables following entirely different routes from the Waterside bus to the switching panels at the rotary station. This important and interesting point being noted therefore and emphasized as it deserves, we may now take up the station electrical equipment, beginning with the generators.

THE GENERATORS.

The 16 General Electric 4500-kw, three-phase generators deliver 25-cycle alternating current at 6600 volts. They are of the revolving

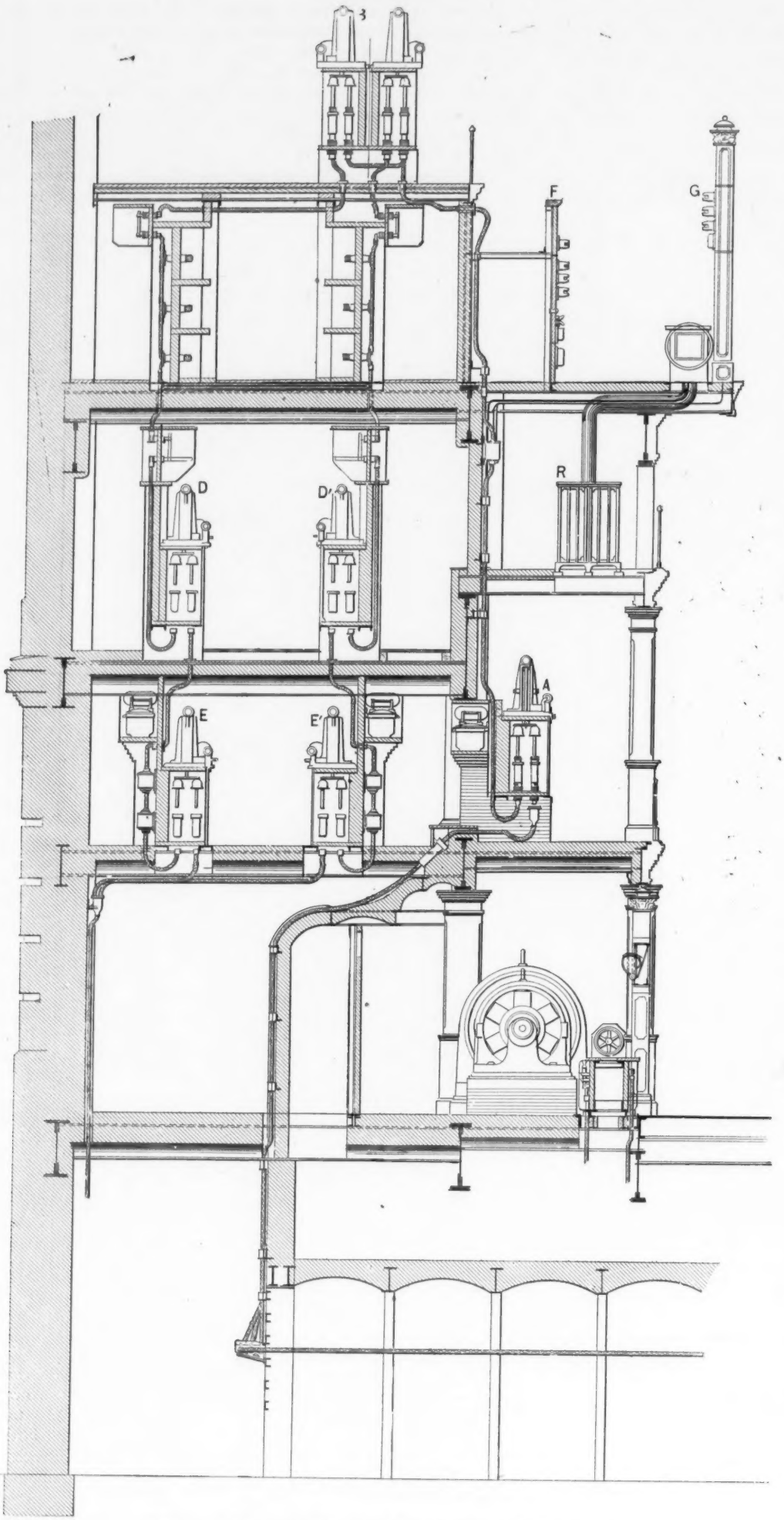


FIG. 19.—SECTIONAL VIEW OF HIGH-TENSION SWITCHBOARD.

A—Generator oil-switch. B—Selector oil-switches connecting generator to either main or auxiliary bus-bars. D—Non-automatic feeder oil-switch. (D′ and E′ same for another feeder.) F—Feeder instrument panel. G—Generator instrument panel. R—Field rheostat, controlled from generator pedestal.

field, direct-connected type, and as they run at 75 r. p. m. have 40 poles. The revolving field is keyed to the engine shaft and bolted to the hub of the flywheel, which is extended so as to form a heavy flange on the side toward the generator. The field magnet cores are bolted to the outer surface of an iron ring, which is made in two semi-circular pieces fastened together by I links. This ring is supported by a spider having eight spokes, through each of which pass two bolts, securing the revolving element to the flywheel hub.

The fields are wound with copper ribbon set on edge, and give full excitation at 220 volts, thus making it possible to take the exciting current either from the low-tension board or storage battery in case of failure of the exciter sets. The exciting current passes to the revolving field through two iron collector rings. Iron rings were used because of their superior wearing qualities. Four carbon brushes on the 1½-inch face of each ring give ample current carrying capacity.

The armature is built of laminated steel of the highest magnetic quality. The armature coils are secured by dove-tailed wedges in slots 4⅛ inches deep and 1½ inches wide. There are 240 slots, 2 per phase per pole. The ends of the coils are so formed as to leave a space of at least an inch between adjacent windings. These end extensions are protected from mechanical injury by curved iron shields bolted to the armature frame.

The revolving field weighs 130,000 lbs., the armature 125,000 lbs., and the foundation plates 20,000 lbs., making the total weight of each generator 275,000 lbs.

The design is such that all necessary repairs to field and armature windings may be made without removing the upper half of the armature. By taking out the two bolts, securing it to the yoke, any field spool may be removed, and by taking out two poles the armature coils may be removed and replaced. The armature coils will carry a non-inductive load of 250 amperes per phase for 24 hours without the temperature of any part exceeding that of the air by more than 30 degs. C. A non-inductive load of 400 amperes per phase carried for three hours causes a temperature rise of less than 50 degs. C. In making the heating tests the resistance method of calculating the temperature was used in addition to thermometer readings. In all cases where the latter gave the higher reading the results as indicated by that method were used.

The armatures are designed to withstand a test of 15,000 volts alternating, applied for half an hour, and a puncture test of 25,000 volts alternating for one minute. The insulation between the field coils, collector

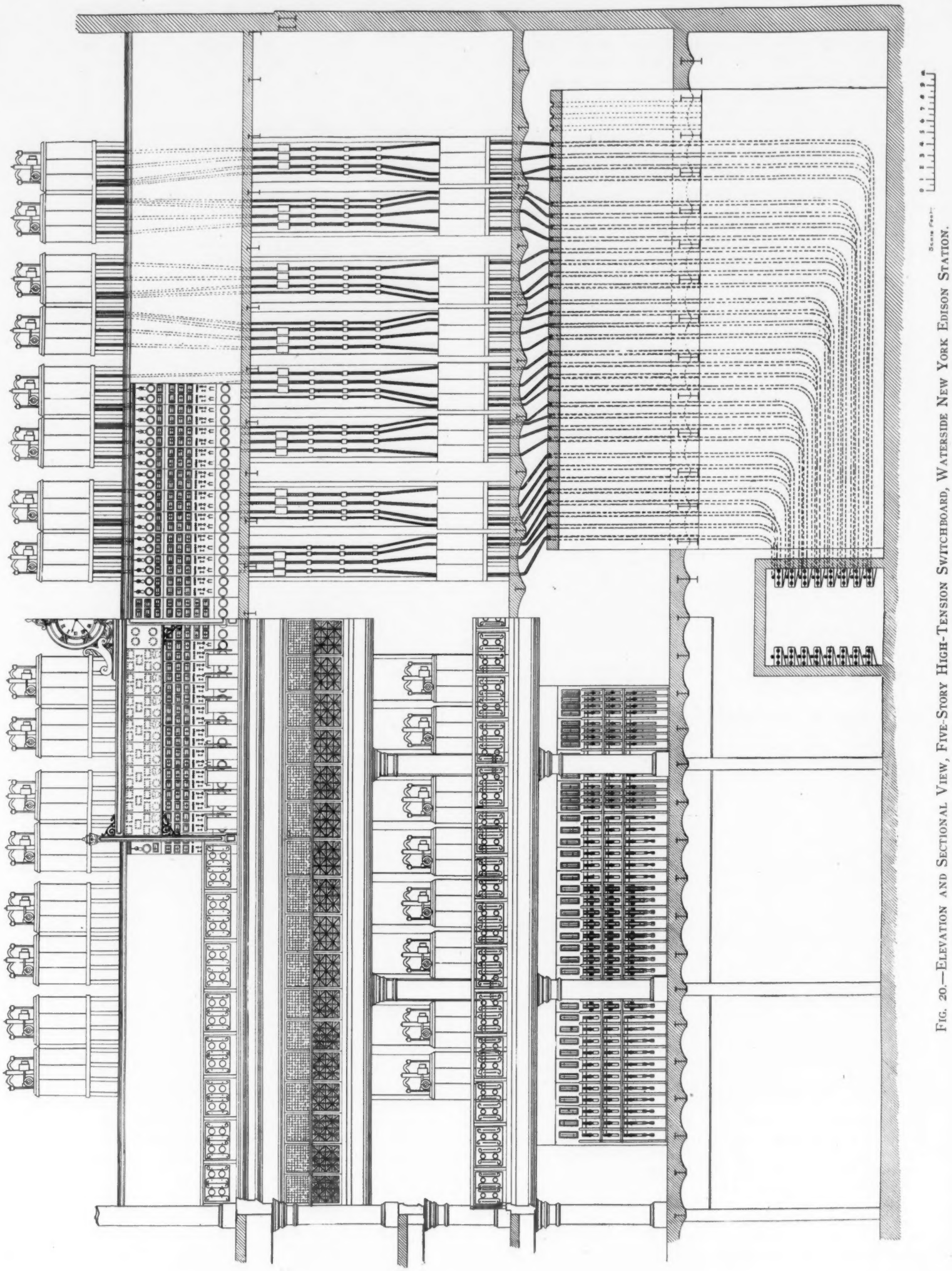


FIG. 20.—ELEVATION AND SECTIONAL VIEW, FIVE-STORY HIGH-TENSION SWITCHBOARD, WATERSIDE NEW YORK EDISON STATION.

rings and generator frame is such as to withstand 25000 volts continuously. The efficiency at full load and one-quarter overload is 97 per cent; at three-quarter load, 96 per cent; at one-half load, 95 per cent, and one-quarter load, 91 per cent. The regulation is such that with the sudden throwing off of full load the rise in voltage does not, with constant excitation, exceed 8 per cent.

MOTOR-GENERATOR EXCITER SETS.

There are three exciter sets installed, each consisting of a 225-hp, 6600-volt, three-phase induction motor, direct connected to a 150-kw, direct-current, 4-pole generator, giving a potential of 200-280 volts. These exciter sets can be run continuously at full load with a rise of temperature not to exceed 40 degs. C. above the surrounding air, and will carry 33⅓ per cent overload for three hours without injury.

In order to insure absolute continuity of current for exciting the fields of the generators a storage battery was installed, having ca-

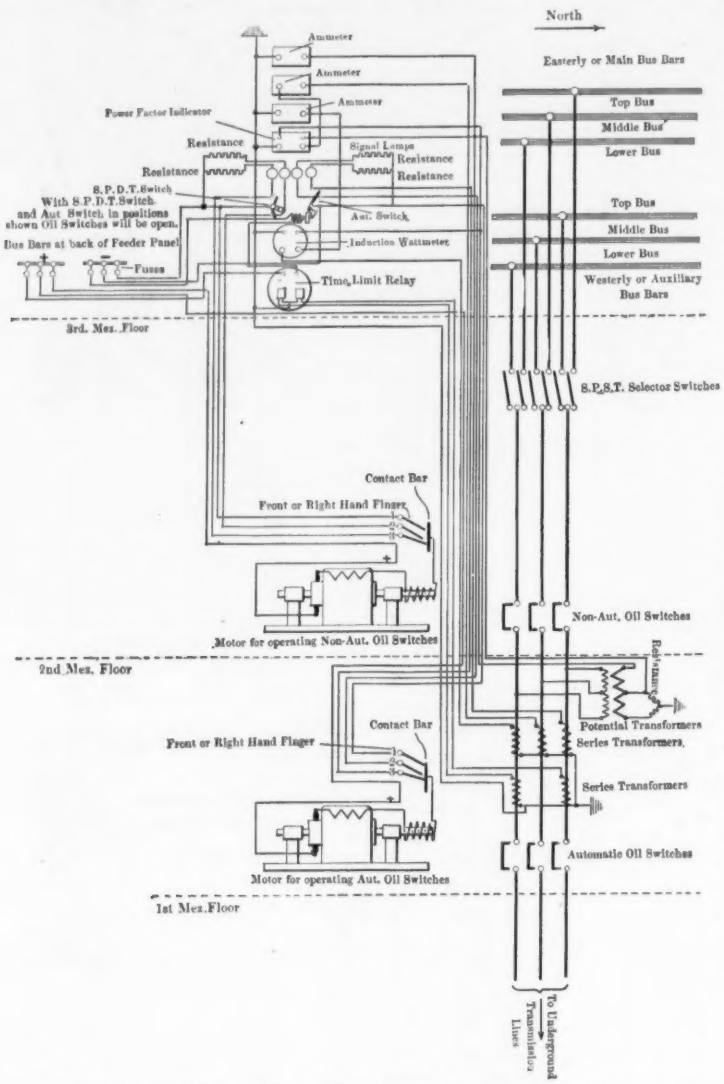


FIG. 21.—DIAGRAM OF STATION CIRCUITS AND SWITCHBOARD CONNECTIONS.
(With Special Reference to G. E. Oil Switches.)

pacity sufficient to excite the fields of 16 generators for one hour. This battery is of the chloride type, built by the Electric Storage Battery Company, and similar to those used in all the annex stations, to be described later in detail.

HIGH-TENSION INDICATING AND CONTROLLING SWITCHBOARD.

The high-tension controlling switchboard of this station differs from those in the two other large alternating-current generating stations in New York, in that each generator is controlled from an individual pedestal, and each feeder from an individual panel, instead of mounting the controlling devices of all the generators upon one bench board, and the controlling device for all the feeders upon another similar board. In this way the small wires which operate the switches, relays, instruments, etc., of one generator are separated from the similar wires of all other generators. With this arrangement the pedestal containing the controlling apparatus for one generator occupies the same lateral space as the panel containing the instruments of the same machine. There is, therefore, no opportunity for the operator to note the indication on the instruments of one generator and by mistake throw the switches of an adjacent machine.

The generator pedestals are 26 inches by 15 inches by 32 inches high, and have mounted on them a field break switch, the rheostat dial switch, the switch for controlling the speed of the engine, the synchronizing plug and the three-pilot switches, which control the main and selector oil switches.

The instrument panels for the generators are mounted directly over their respective pedestals upon girders carried upon three columns, as shown in the general cross-section. Upon each panel, which is 2 ft. wide by 3 ft. 3 inches high, there are three ammeters, one voltmeter, one power factor indicator, one integrating wattmeter and the field ammeter. The current for operating these instruments is supplied by series and potential transformers connected in and across the generator cables; one lead to each instrument being grounded for safety. The two center panels have each mounted on them eight ammeters, which are connected one to a phase of each of the eight generators on that side of the aisle. This enables the operator to see at a glance the load on each generator.

The instruments for the feeders and the pilot switches, relays, etc., for controlling the feeder oil switches are mounted on panels directly back of the generator pedestals. Each feeder occupies a space 11 inches wide upon this panel board. At the top are pilot lamps and below these is the indicating wattmeter, the power factor indicator, three ammeters, the pilot switches for controlling and the colored lamps for indicating the position of the oil switches and the time limit relays. The two center feeder panels have each mounted on them 20 ammeters, which indicate at once the load on all the feeders.

It may be added that the instruments described above are of the horizontal edgewise type, built by the General Electric Company.

The generator cables are single conductor, 500,000 cm. copper, insulated with 12/32-inch paper and protected by ⅛-inch lead. The generator field cables are single conductor, 212,000 cm. insulated, with 5/32-inch rubber and lead covered. These five cables, together with the seven conductor lead-covered cable for signaling purposes, are carried from each generator on iron brackets in the central cable runway to the cable vault under the switchboard. In the runway the six cables of one generator are separated from the cables of the adjacent generator by cast-iron septums. From the cable-vault the generator cables are carried up in individual brick ducts to the generator switch. This switch is of the General Electric motor controlled oil type. It is mounted in a cell structure built up of buff brick, firebrick and soapstone. The two potential transformers are also mounted in this same structure and completely enclosed in the fire-resisting materials mentioned. The primaries of these transformers are connected to the same phase, one on the generator and the other on the bus side of the switch. These transformers are used for synchronizing and are so connected that when the potentials on the two sides of the generator switch are equal and are in phase with each other, the synchronizing voltmeter indicates zero. In this way it is impossible to synchronize a generator with the auxiliary bus, and then throw it in on the main bus. These same transformers also furnish potential for the voltmeter, power factor indicator and the integrating wattmeter. Above the main switch the cables are carried up between brick barriers to the series transformers, which operate the instruments, and then on to the oil selector switches above the bus house. These switches are similar to the main switch, and allow a generator to be connected to either bus. The controlling switches and wires for them are so arranged that it is impossible to close both the main and auxiliary bus switch at the same time.

THE BUS-BARS.

The high-tension bus-bars are mounted in a bus house built of buff brick and firebrick directly behind the high-tension controlling switchboard. There are two sets of bus-bars, the main and an auxiliary, to either of which any feeder or any generator can be connected. The group bus-bar system was not deemed advisable in this case, but it is possible, however, to divide each bus at the center of the station, thereby giving four sets. Each bus-bar is composed of four strips of three by one-eighth inch rolled copper supported on studs, which are enclosed in linen tubes and pass through porcelain insulators, as shown in the drawings. The bus-bars are spaced about 3 ft. apart, and separated by 3-inch firebrick slabs, so that it is practically impossible for a short circuit to occur between them. On the outer end of the studs supporting the bus is a plate to which are attached three cable lugs, one for the generator cable coming from the

floor above and two for the feeder cables running down through the floor below. The cables to the different busses are 12 inches apart, and separated by 4-inch brick barrier walls. These feeder cables pass through porcelain floor tubes to the feeder selector switches. These are of the knife-blade type, mounted on glass pillars on soapstone bases, and efficiently protected by soapstone barriers. An interlocking device is provided for these switches so that it is impossible

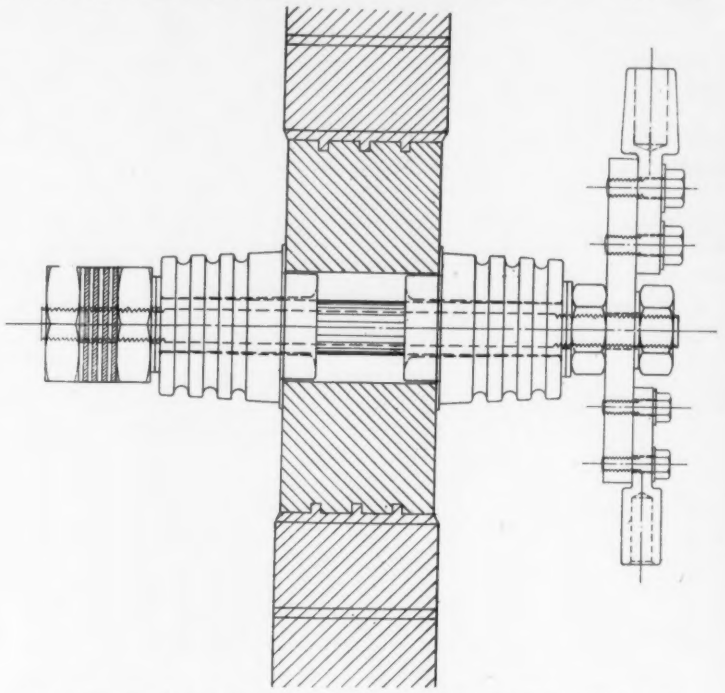


FIG. 22.—SUPPORT AND REAR TERMINALS FOR HIGH-TENSION BUS.

to connect a feeder to both busses at the same time. Directly below the selector switches are the feeder oil switches. There are two of these in series on each feeder, the single conductor cables between them being recessed in brick ducts. The upper one is controlled only by the pilot switch on the feeder board, but the lower one in addition acts as a circuit breaker, and is opened automatically by the overload and time limit relay.

This overload time limit relay is adjustable and can be set to open the automatic oil switch when the current in the feeder exceeds a

FIG. 23.—BUS-BAR PARTITIONS AND CORRIDOR BACK OF HIGH-TENSION SWITCHBOARD.

given number of amperes for a given period of time. If before the expiration of the time limit the current again drops below the amount for which it is set, the oil switch does not operate, and the time limit relay resets itself automatically. The range of the time scale of this relay is from 2 to 6 seconds, and the range in current is from 2 to 6½ amperes. As the series transformers in use with these relays have a ratio of 70 to 1, they can be set to operate when the current in the feeder is at any point between 140 and 455 amperes.

The time limit relays in the Waterside station are set to open in 4 seconds; those in the sub-stations at points where feeders branch are set for 2 seconds, and the overload relays in the sub-stations at which the feeder terminates are set to open instantaneously.

The cell structure of the oil switch on the lower feeder switch-gallery contains the series and potential transformers for operating

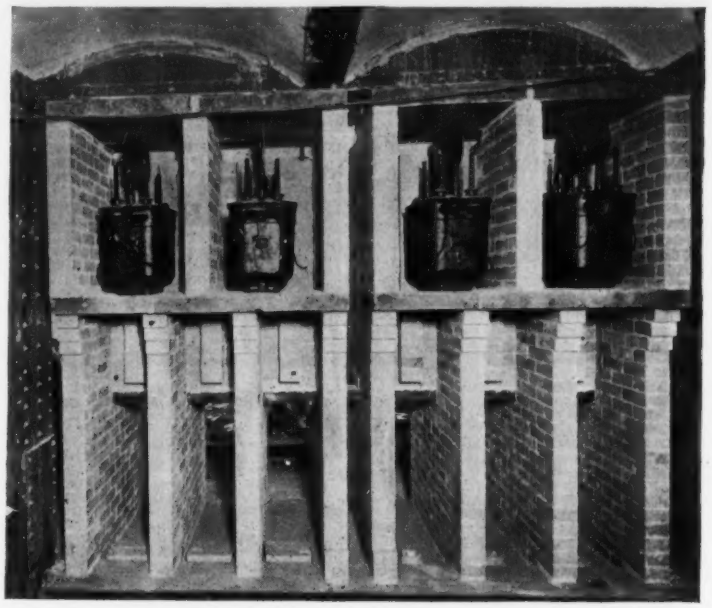


FIG. 24.—POTENTIAL TRANSFORMERS FOR VOLTMETERS ON HIGH-TENSION BOARD.

the relays and feeder instruments. These, as will be seen by referring to the cross-sections through the electrical galleries, are completely enclosed by buff brick and firebrick cellular partitions.

The three conductor lead-covered feeder cable coming from the street ends at a point directly below the lower feeder switch. A specially designed right-angle bell, or terminal head, is placed on the cable, from which three single conductors are led into the bottom

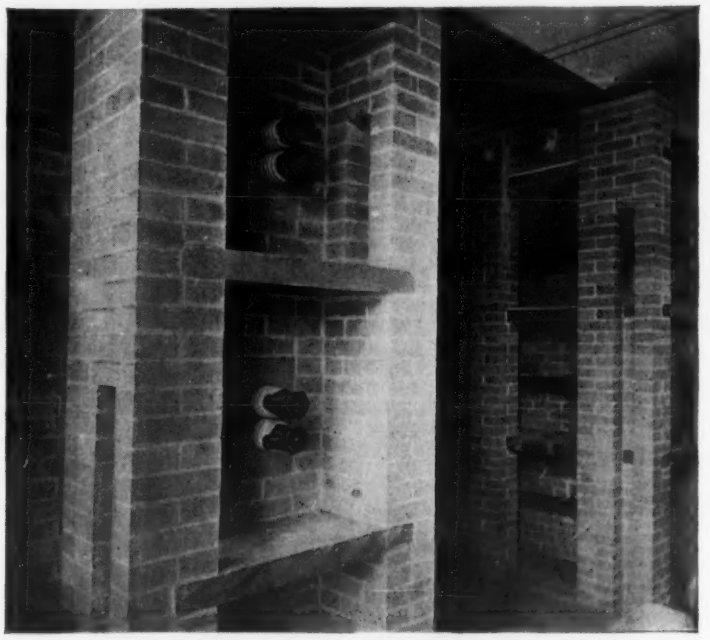


FIG. 25.—END OF HIGH-TENSION BUS-BARS.

terminals of the switch. These single conductor ends are just long enough to permit any one of them being placed on any of the terminals of the oil switch directly above it, thus giving an opportunity to twist the conductors when necessary for multiple connection with other feeders.

From the lower feeder switch to the manholes in front of the sta-

tion, each three-conductor cable is separated from the one on either side of it by iron or brick septums.

GENERAL SWITCHBOARD DATA.

As will have been seen from the diagrammatic plans, the high-tension switchboard, which is placed at the west end of the building, occupies four galleries. The main operating board, as described above, is on the third gallery on practically the same level as the top engine platform. Resuming in detail the features referred to, the course of the current from a single generator can be traced by referring to Fig. 19, which is a vertical cross-section through all four galleries. From the generator the current is carried in single conductor cables through the generator oil switch *A* on the first gallery, to the oil selector switch *B* on the top gallery. The object of these selector switches is to permit the generator to be connected to either the main or auxiliary bus-bars, both of which run along the rear of this gallery. From the bus-bars the current passes down through two-oil break switches, *D* and *E*, to the feeders. The object of having two switches in series is to make certain that one at least will operate to cut off the feeder when necessary. From the oil switches the feeders pass down to the basement and out into the subways, as shown in Fig. 20.

The vertical section, 4 ft. wide through the switchboard galleries, thus contains all the high-tension connections of one generator, and is so thoroughly protected by the fireproof brick partitions that it is claimed that one section complete with cables, switches and transformers might be burned up without injury to any of the others.

OIL SWITCHES.

The oil switches used are of two types, one furnished by the General Electric Company, and the other by the General Incandescent Arc Light Company, both being new types. In the oil switches supplied by the General Electric Company six simultaneous breaks are made by the raising of copper connecting *U*'s fastened to a common yoke by wooden rods. Fig. 21 shows the connections for operating these switches. The heavy lines on the right indicate the course of the high-potential current from the bus-bars to the underground transmission lines. The lighter lines show the connections for operating the oil switches and indicating instruments. The switch designated "automatic" is so called because it is opened by an overload relay; the non-automatic switches being controlled only from the switchboard.

With the connections as shown the oil switches are open. They are closed as follows: The small controlling switch, marked S. P. D. T. is raised, thus making contact on the upper point. This closes the circuit through a ½-hp series motor and a solenoid shown at the end of the shaft. The motor starts, and at the same time a worm and gear wheel is connected to it by the action of the solenoid. The gear wheel revolves and carries a crank-pin off a dead center, which pin is the middle point of a toggle. As soon as it is carried out of line, a powerful spring closes the oil switch, carrying the crank pin through nearly 180 degs. This motion is independent of the motor, which runs free, gaining speed as the spring closes the switch. There is a ratchet connection between the crank shaft and gear wheel which permits the former to be carried around by the switch mechanism free of the latter. The moment the action of the spring ceases the ratchet catches and the crank-pin is carried through the remainder of the 180 degs. by the motor, which then cuts itself off. The crank-pin is then again on a dead center, being now the lower point of a toggle. During the latter part of the closing action, the opening spring is compressed and four spiral springs are extended, all tending to open the switch but unable to do so, because of the condition due to the dead center. The entire operation takes about one second.

The main switch may now be opened by throwing the operating switch to the lower contact, closing the motor circuit through the finger 2. The toggle is thus upset and the switch flies open, actuated not only by the opening spring, which is similar to that which closes the switch, but also by the four extra springs. The opening is, therefore, made even quicker and more certain than the closing action.

The only difference between the automatic and non-automatic oil switches is that the controlling switch of the former, marked "Aut. Switch" in the figure, in addition to being operated by hand, is opened by a tripping solenoid in case of overload.

Guide rods are provided, which prevent binding against the soapstone cover and insure the accurate alignment of the contact parts. If it is desired to operate the compartment switch by hand a pair of rods with screw eyes at the base are provided into which can be hooked into a handle for operating it manually. Air bumpers are supplied to take up the final rush of the solenoids, so that no jar is transmitted to the supporting structure.

Fig. 30 shows the connections by which the main switch is operated from the switchboard or by the time limit relay. The cut shows the switch open; to close it, close the operating switch, thus energizing the right solenoid. The switch starts to move and almost instantly the blade *A* moves from point 1 to point 2, shutting the operating switch so that the motion of the main switch must continue until it is completely closed. At the moment of closing the blade *A* moves from point 2 to point 3, leaving the switch ready to be opened. In opening, the blade *A* jumps first to point 4, shunting the operating switch, and when the main switch is open, returns to 1, completing the cycle and leaving the connections, as shown in the figure.

The time limit relay is operated by current transformers in the feeder circuits. Should the current in the feeder exceed the amount for which the device is set, one of the small plungers shown is raised, and releases a disk, which revolves until it closes the circuit of a tripping solenoid which opens the operating switch. This opens the main switch in the manner already described. The relay may be set so as to take any desired amount of time after the contact disk starts before it finally opens the operating switch. The figure also shows the connections by which the pilot lamps indicate to the operator the position of the main switch. The contacts for this are independent of the position of the operating switch.

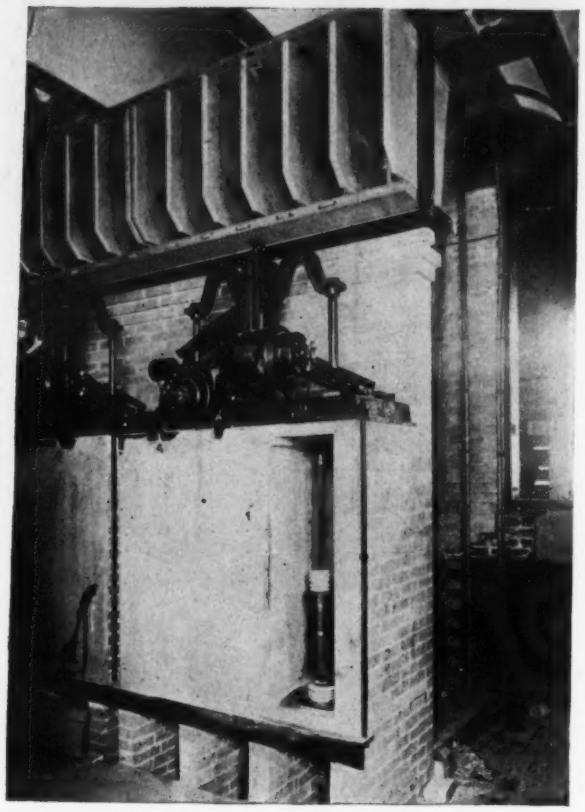
The General Incandescent switch chamber is of brick, divided by soapstone partitions into three compartments, one for each phase, and has a removable soapstone front. In each compartment are two oil wells, consisting of seamless brass tubing, with insulating lining, mounted upon porcelain insulators and connected by an inverted copper *U* connector. A wooden rod, which, after heating to drive out the sap, has been boiled in paraffine for 24 hours, connects this *U* to an iron rod at the top of the switch to which the *U*'s in the other two phases are similarly joined. This iron rod has a motion of over 14 inches, and when raised lifts the *U*'s in the oil chambers so as to make two 12-inch breaks in each phase. The switch is actuated by two solenoids, which operate a crank and connecting-rod movement so arranged that very little work is required of the solenoid at the beginning and end of its motion. The cores of the solenoids are connected by a steel tape passing over a wheel, which is turned 180 degs. to the right or left, as the right or left solenoid is excited.

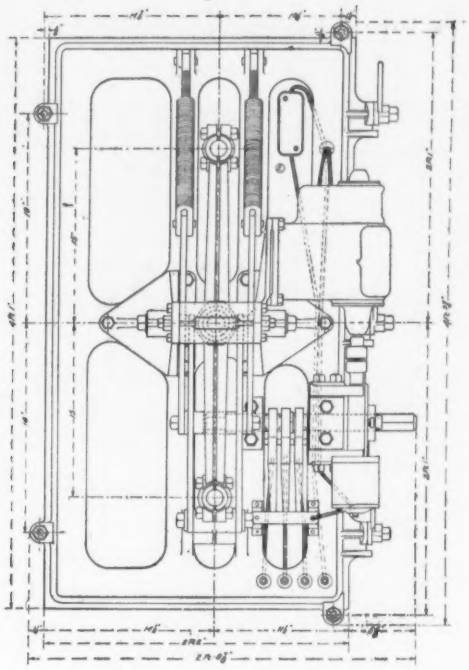
THE LOW-TENSION SELECTOR SWITCHBOARD.

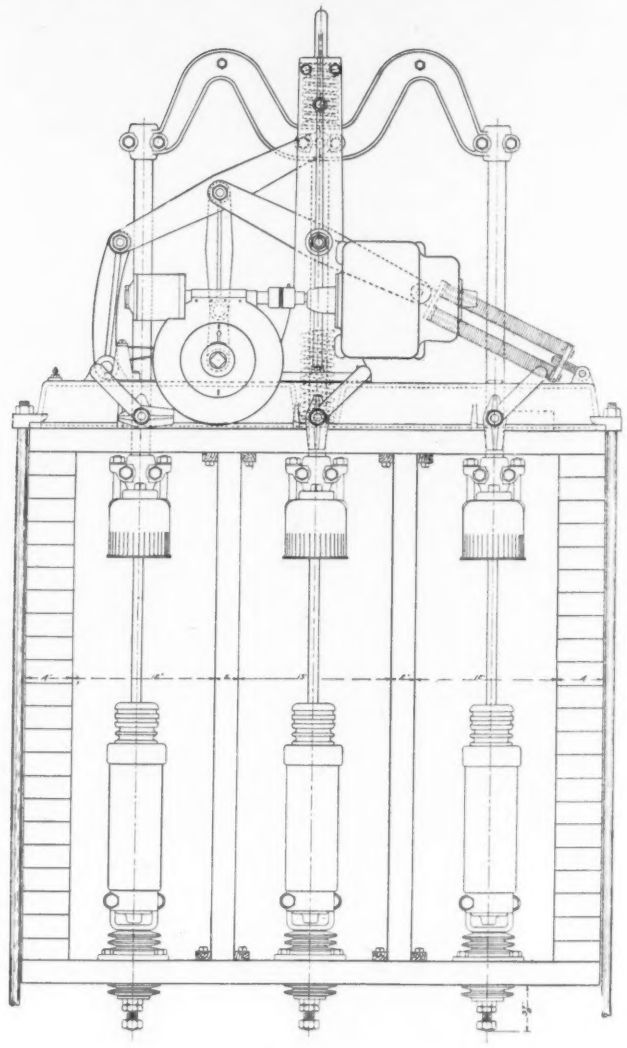
The low-tension selector switchboard (Fig. 33) on the first floor really consists of two distinct switchboards, each with three sets of bus-bars, which in case of emergency can be tied together. One of these is the exciter switchboard, from which is supplied current to the fields of the generators, and all the apparatus for operating the generator and feeder oil switches, relays, etc. The other switchboard is that of the local rotary converter sub-station, which supplies the low-tension feeders in the neighborhood, and also the crane, elevator and other motors in the building.

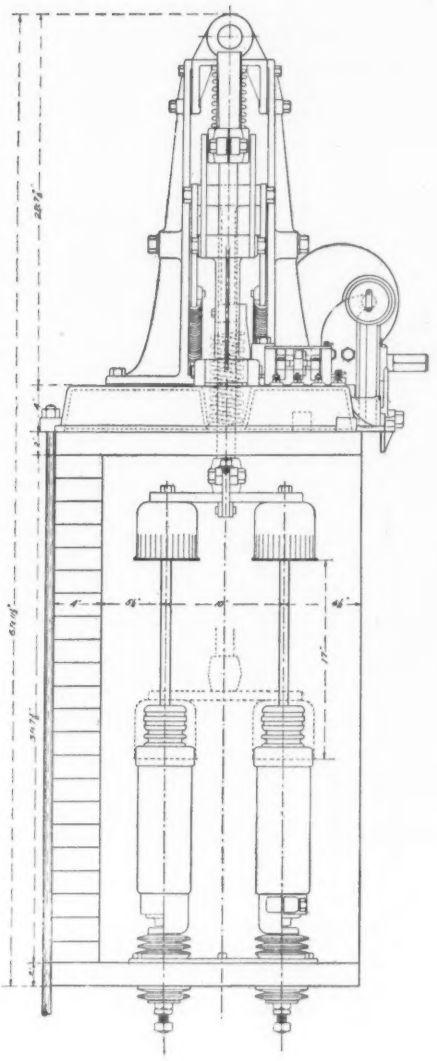
For the exciter bus-bars the current is furnished by the four exciter generators and exciter storage battery, which will be charged by a special booster. In general practice the exciters and generator fields will be connected to the lower set of bus-bars, which will be run at a potential of 240-250 volts. If it is necessary at the same time to carry the extreme overload with low power factor on some of the generators, thereby requiring maximum field excitation, their fields will be connected to the upper bus-bars, which will be supplied with current via the booster, or by an exciter run at higher voltage. The middle bus-bar of the exciter switchboard will be connected by the tying-in switch to the same bus-bar on the local rotary switchboard, so that current from the rotaries can be used for field excitation in so that current from the rotaries or from the feeders connected to the general external low-tension network can be used for field excitation in case of emergency.

The exciter generators will feed the bus through reverse current circuit breakers, so that in case of the high-tension circuit breaker opening on the alternating-current motor, the direct-current generator will be automatically disconnected from the bus as soon as it "motor-will be automatically disconnected from the bus as soon as it runs as a motor. For the local rotary station bus-bars the current will be supplied by six rotaries of 500 kw capacity each, a local storage battery and a local booster. To this bus are connected eight low-tension feeders, which supply the section of the city between Fourth Avenue and East River and Thirtieth and Fiftieth streets.

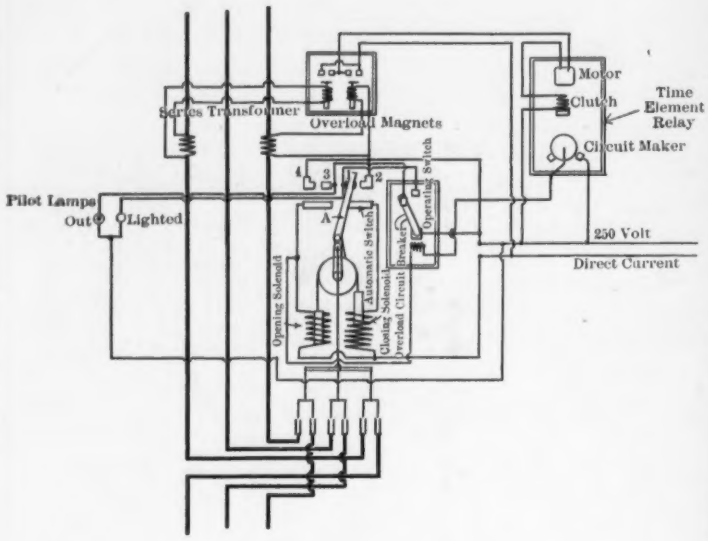


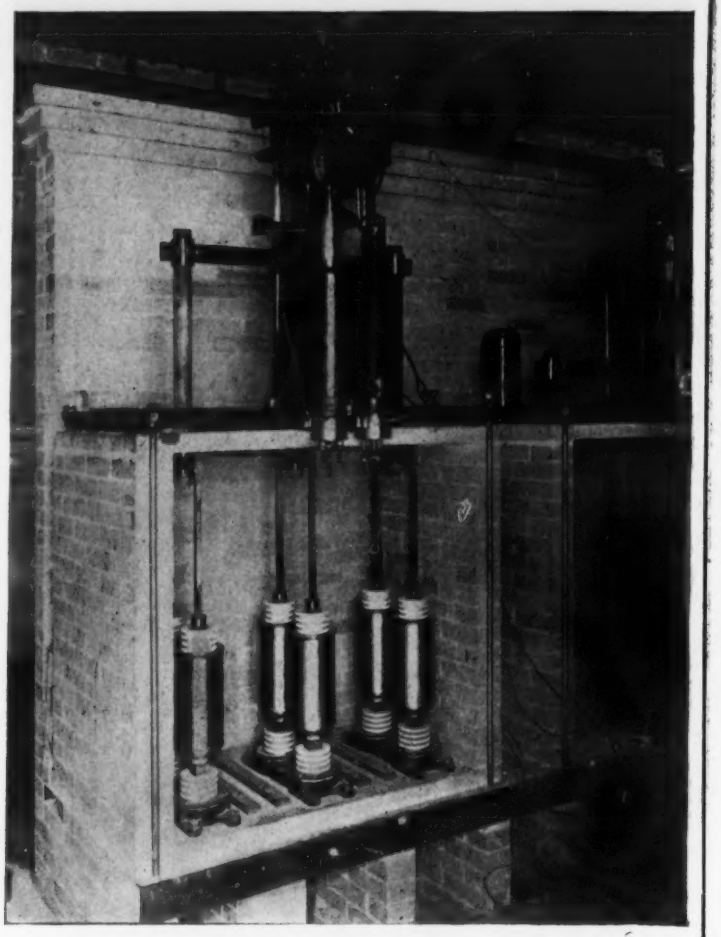


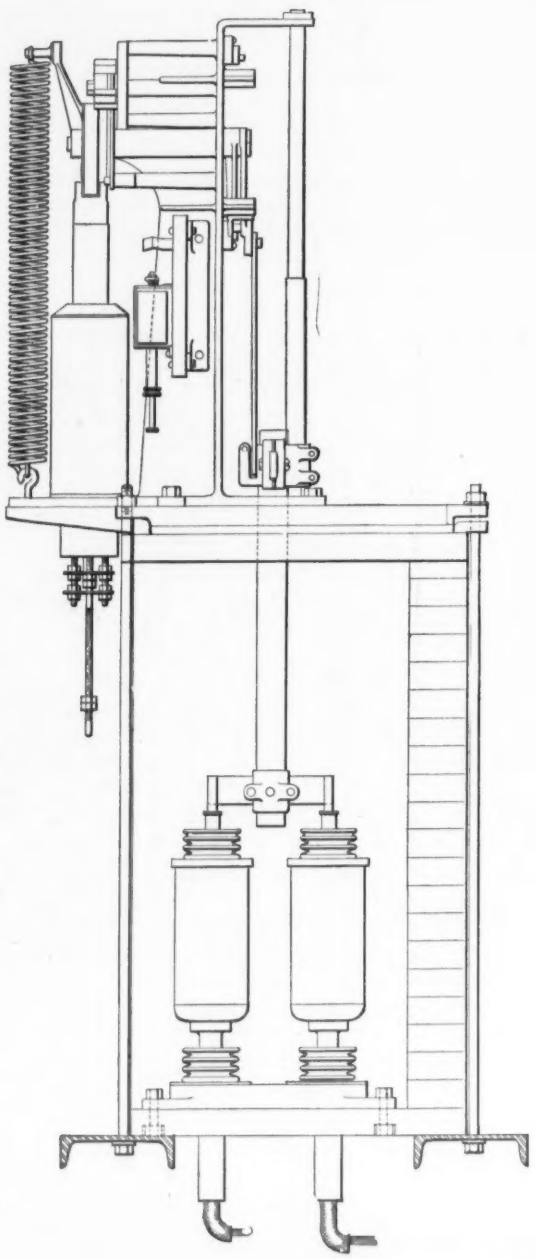


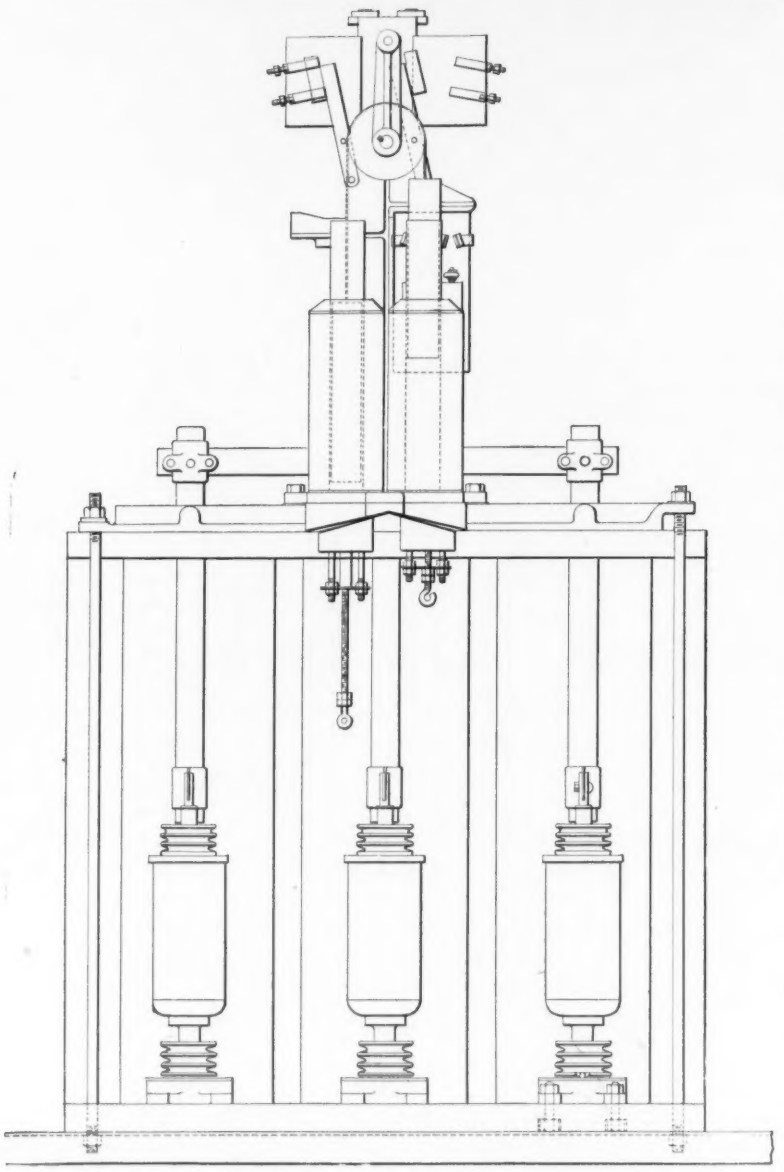


FIGS. 26, 27, 28 AND 29.—GENERAL ELECTRIC OIL SWITCHES.
WATERSIDE PLANT, NEW YORK EDISON COMPANY.









FIGS. 30, 31, 32 AND 32a—GENERAL INCANDESCENT OIL SWITCHES.

At present there is but one battery and one booster installed, and the two switchboards are operated as one. This was rendered possible by having the fields of the main generators, the fields of the exciter generators, the motors (or solenoids) on the oil switches, tripping coils of the time limit relays, crane motors, elevator motors, coal conveyor motors, etc., etc., all wound to operate satisfactorily at from 240 to 250 volts.

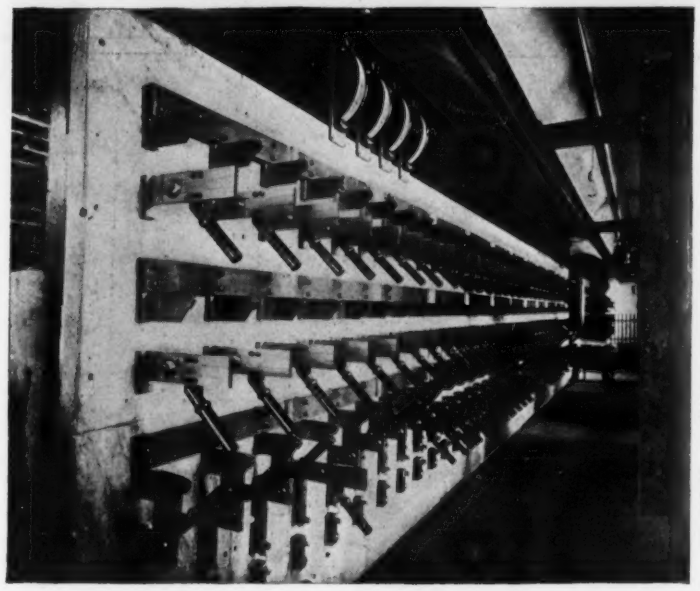


FIG. 33.—ONE SECTION OF LOW-TENSION SWITCHBOARD.

The low tension selector switchboard was built by the General Incandescent Arc Light Company, on the specifications of the New York Edison Company. All the ammeters are of the Van Vleck edgewise pattern, manufactured by the Weston Electrical Instrument Company. They are of the shunt type. For the ammeters on the feeders, part of the conductor is used for the shunt. In all other cases special alloy shunts are used.

LOW-TENSION OPERATING SWITCHBOARD.

The rheostat dials, switches, etc., for controlling the exciters, rotaries and boosters are mounted upon pedestals, and directly above the pedestal of each machine is a marble panel containing the in-

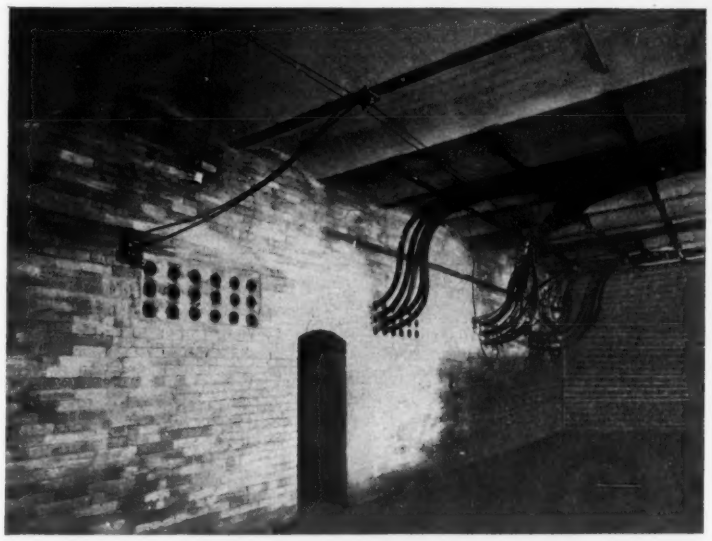


FIG. 34.—CABLE VAULT.

struments. On each exciter pedestal there is a direct-current main switch, the field rheostat dials, field-break switch and the pilot switch and overload relay for controlling the oil switch. The work the exciters are doing is indicated by an alternating-current ammeter and power factor indicator for the motor, and a direct-current ammeter for the generator. On the rotary pedestal is a combination starting and main switch, by which the rotary is started as a direct-current motor. When this switch is in the starting position a rheostat and a fuse are in series with the armature; when completely closed in its running position, the fuse and starting box are short circuited. Above this switch is the field rheostat dial, the field-break switch, receptacles for synchronizing and balancing plugs, and pilot switch for operating the magnetic switches which are placed between the static transformers and the rotary.

On the booster pedestals is a combination starting and main

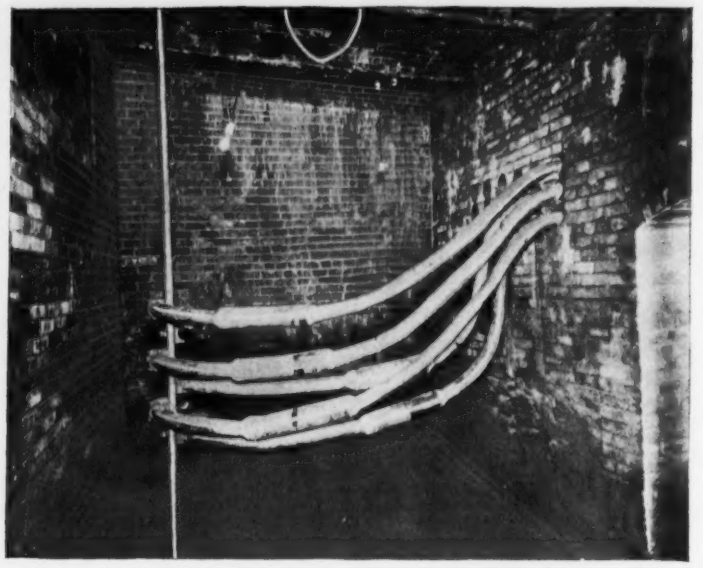


FIG. 35.—CABLE VAULT MANHOLE.

switch for the booster motor and main switches for closing the circuits of each of the booster dynamos.

The bus from which current is to be taken and the bus to which it is to be fed are determined by the switches on the selector switchboard. Above these are the rheostat dials for each dynamo, field switches, etc.

The apparatus for the control of the battery is mounted directly above the booster pedestal. This consists of four special reversing switches of the push-button type, furnished by the Electric Storage

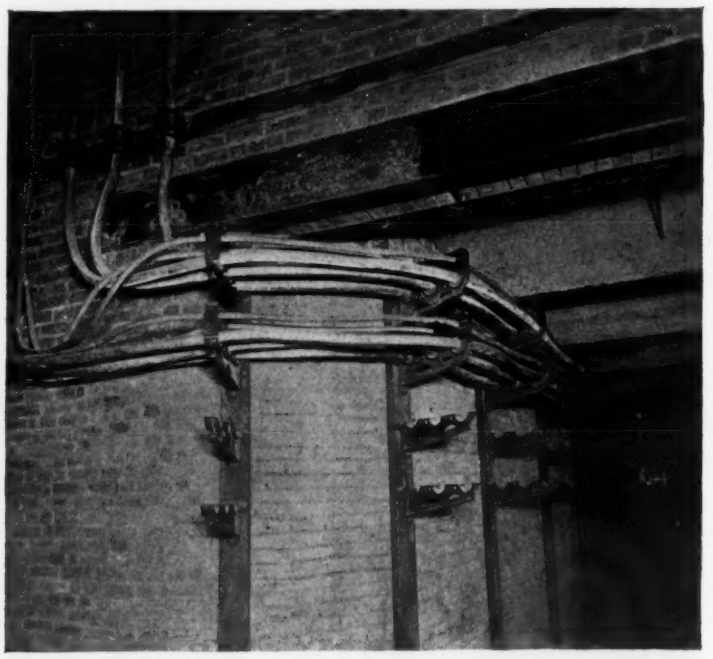


FIG. 36.—CABLE RUNWAY UNDER THE DYNAMO ROOM.

Battery Company. These switches control the motors operating the cell switches, which are placed in a room in front of the battery room and separated from it by an "acid fume proof" partition. Above the push-button switches are the indicators, which show the number of cells in circuit, that is, the position of the end cell switches.

THE CABLE VAULT.

The cables coming from the generators are carried on cable racks

through a cable vault running the full length of the operating room between the two rows of engine foundations. A view of this vault showing some of the cables in position is given in Fig. 36. Each rack contains three lead-covered, paper-insulated, single-conductor cables of 500,000 circ. mills cross-section, two lead-covered cables carrying the field current, and smaller wires for the motor operating the engine governor, signaling, etc. Each rack contains the wiring for one generator, and is separated from its neighbors by fireproof partitions.

From the cable vault the cables are fanned out and pass up through bricked-in cable ways to the oil-break switches on the first switchboard gallery.

The cable vaults by which the cables leave the building are also shown in Figs. 34 and 35. They are of most ample and solid construction, there being in reality a fine large cable chamber extending out from under the west front of the station, with abundant duct capacity for increase in service up to the full generating limit of the plant.

Electrical Equipment of the Manhattan Elevated Railway—I.

IN our first issue of last year a description was given of the generating plant and electrical equipment of the Manhattan Elevated Railway. During the past year the work on the plant proceeded rapidly, and it is announced that the first electric train for public conveyance will be run the present month; in fact, an experimental train may be said to be already in successful operation, and the addition of the road on an electrical basis to the rapid transit facilities of New York is eagerly awaited by the citizens. As already understood, it is proposed to start out electrical operation of the system with the Second Avenue line, and the other divisions will be taken up in regular order. An immense amount of work was necessarily done during 1901 in completing the initial equipments of the great power plant, as well as in securing rolling stock, completing track work on the Second Avenue line and making the innumerable investigations, tests, etc., that were necessary before an enterprise of this magnitude could be perfectly adapted to its destined work. Messrs. Skitt, Baker, Stillwell ,Stott and others, in fact, all the executive officials from President Gould down, have had their attention engrossed during the past twelve months by the

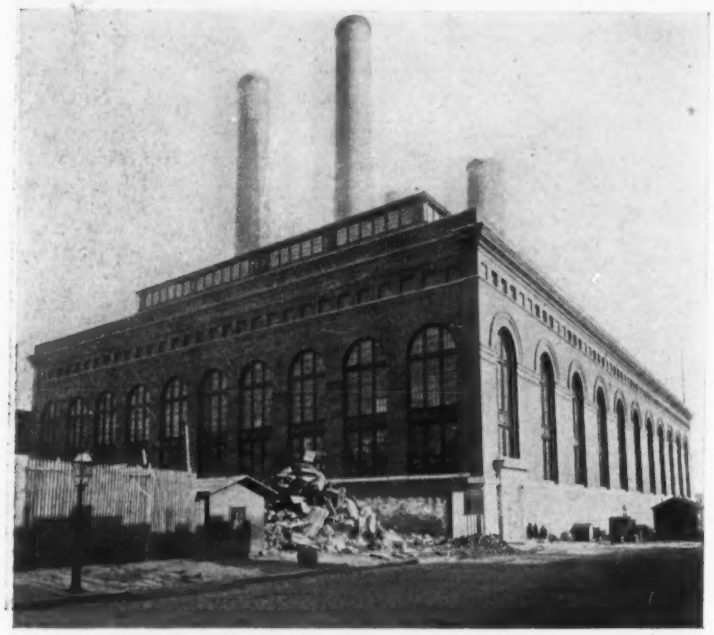


FIG. 1.—EXTERIOR OF POWER HOUSE.

heavy problems of this enterprise, and are, of course, still in the very thick of it. The data and the few views which are given in this and a succeeding article must, therefore, be considered as of merely a tentative nature pending fuller description and treatment of the various features of this most interesting and important work.

The central generating station, an exterior view of which is given in Fig. 1, is an imposing structure occupying the block bounded by Seventy-fourth, Seventy-fifth and Exterior streets, and fronting on the East River, this being the most centrally located site available. All the current is generated here, the plant having a maximum capacity of 80,000 hp. The main building is divided by a longitudinal wall into two parts, the boiler plant and accessories occupying one-half and the engines and dynamos the other. The dimensions of the

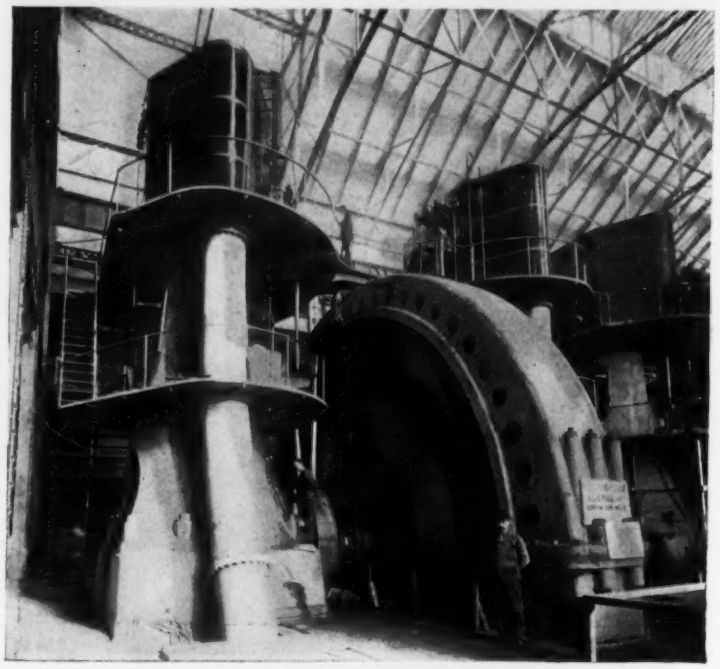


FIG. 2.—VIEW OF ENGINES AND ONE GENERATOR.

building are 204 ft. 4 inches wide, 395 ft. deep on Seventy-fourth Street and 413 ft. on Seventy-fifth Street.

The unit plan was adopted for the general design of the power plant, the equipment being arranged in eight complete and practically independent units, each consisting of one engine and alternator, four batteries of boilers, one condenser and one boiler-feed pump, all connected by the necessary piping. The location of the plant on the river front affords an easy and economical means for handling coal and ashes.

The boiler equipment comprises 64 Babcock & Wilcox horizontal

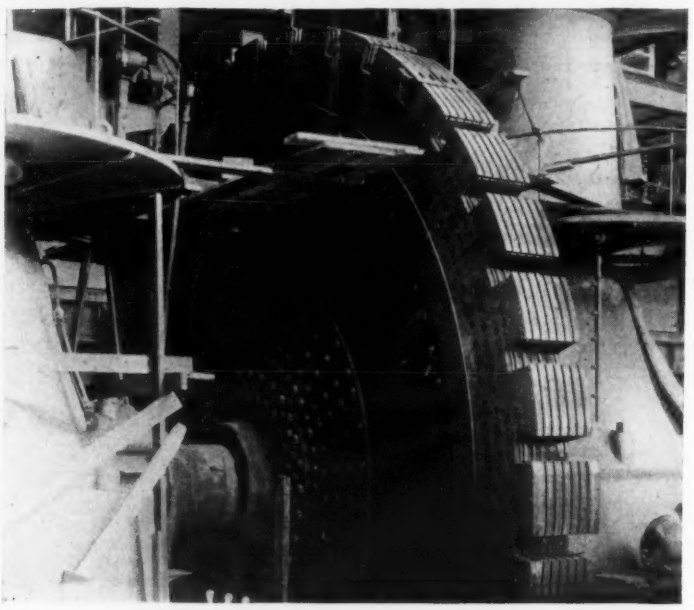


FIG. 3.—REVOLVING FIELD.

water-tube boilers of 525 hp each, arranged in batteries of two each, and capable of sustaining safely 200 lbs. working steam pressure. Mechanical stokers of the Roney type are used, and it is estimated by the engineers for the Manhattan Company that while at least 270 men would have been required to fire these boilers by hand, with the mechanical stokers, this force can be reduced to 90 men, a saving in labor alone of over $400 per day. Another important advantage thereby gained is that hard or soft coal may be used, either separately

or mixed. For this no alteration is required in the arrangement or construction of the stoker, merely a different adjustment of the feed and grate-actuating mechanism. The present installation will consist of 256 stokers under the 64 525-hp boilers, and they will be capable of developing 50 per cent above the rated capacity of the boilers. The total equipment when the plant is completed as designed will consist of 384 stokers attached to 96 525-hp boilers, or a total of 50,400 hp, making this the largest boiler plant ever designed or installed.

Sixteen Green fuel economizers are employed, one for every two batteries of boilers. They are of the high-pressure type and aggregate 8192 tubes. Huge stcks have been erected, which are of sufficient dimensions to furnish enough draft for ordinary requirements, but as a precautionary measure 16 Sturtevant blowers are installed to furnish forced draft when needed. These blowers will be operated by alternating-current motors. All of the feed pumps, eight in number, of the Gould triplex, single-acting type, are driven by 500-volt direct-current motors.

The generating machinery will comprise eight 5000-kw Westinghouse alternators, directly connected to Allis-Corliss engines, of which two units are now ready for use, the others being in various stages of completion. A general view of the generating room is given in Fig. 4, and another view in Fig. 2. Each unit has a nominal rating of 5000 kw, but has a maximum capacity of 10,000 hp, and enjoy the distinction of being the largest electrical generators that have ever been erected.

The steam engines were built after designs of Mr. Edwin Reynolds, and each consists of a pair of compound engines working upon the same shaft, the high-pressure cylinders being horizontal and the low pressures vertical, the high and low of each end taking hold of the same crank pin. The dimensions are 44 inches and 88 inches and 5 ft. stroke, the revolutions being 75 per minute.

The capacity of the engines is from 7500 hp to 12,000 hp maximum. To get this capacity into a two-cylinder engine of the ordinary cross-compound type would require cylinders 62 and 124 inches in diameter. By the use of four cylinders each crank is given four instead of two impulses at each revolution, which makes the turning effort upon the shaft so uniform that the revolving field of the generator takes the place of the flywheel. The ordinary Reynolds-Corliss valve gear is employed, with a single eccentric on each high-pressure cylinder and separate eccentrics for the steam and exhaust valves of each low-pressure cylinder. The two sides of the engine are entirely distinct, and one can be run with the other uncoupled without affecting its steam efficiency.

Each of the great Westinghouse generators delivers three-phase currents at 11,000 volts, which, if necessary, may be raised to 12,000 volts. The wave-form generated is practically a true sine curve under all conditions of load and power factor, and the regulation from no-load to full load is guaranteed to be within 6 per cent. The rise in temperature above the surrounding air of any part of the machine under full load for 24 hours is not to exceed 35 degs. C., and at 50 per cent overload, or 7500 kw, it is not to exceed 55 degs. C. The efficiency at full load from engine to switchboard is 96.5 per cent.

The revolving parts of the dynamos are particularly designed to secure very unusual strength and consequent ability to resist the tendency to burst and fly apart in case of temporary abnormal speed through accident of any kind. The hub of the revolving field, which is also the flywheel of the engines, is of cast steel, and the rim is carried not by the ordinary spokes, but by two webs of rolled steel.

The angular velocity of the revolving field, as determined by the

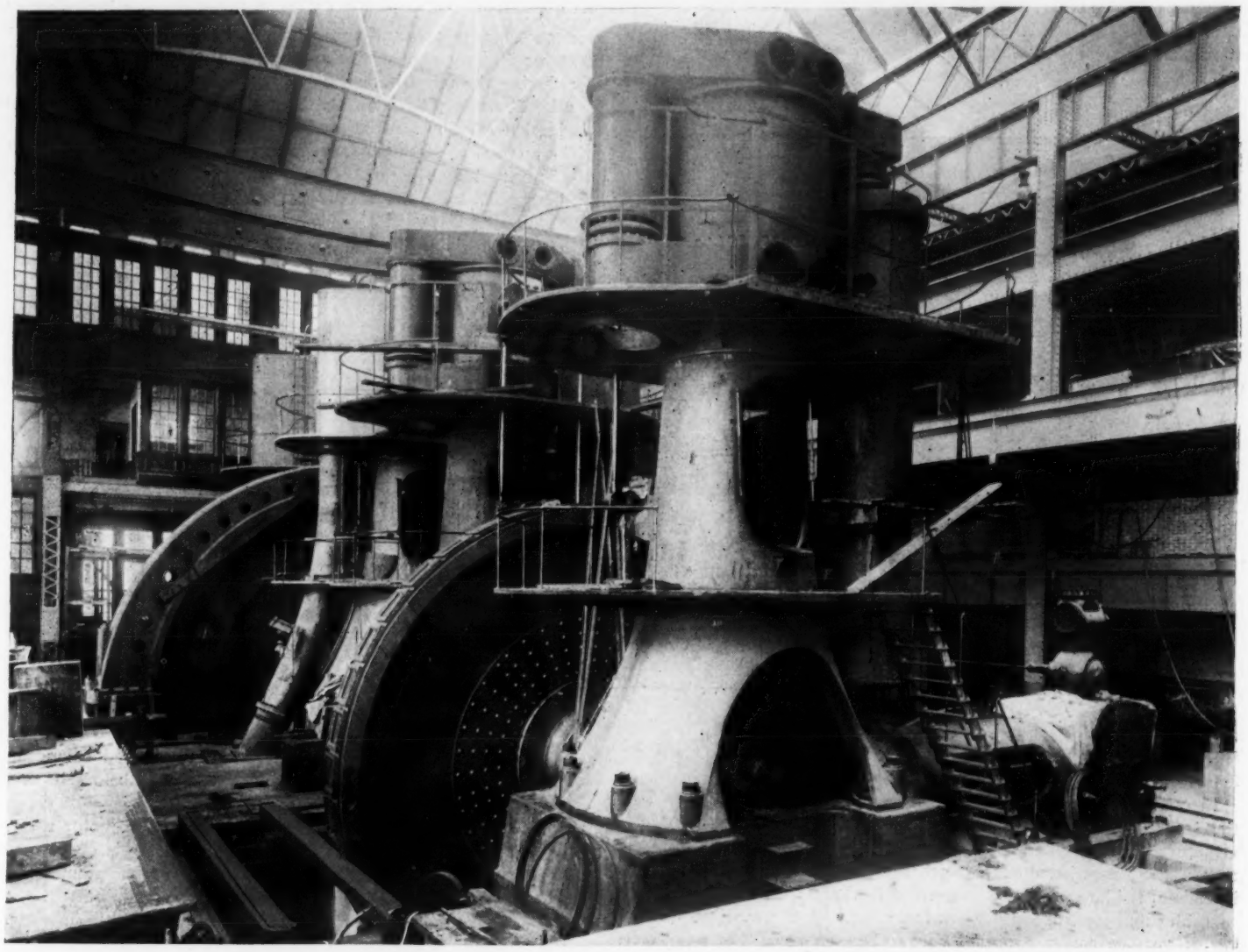


FIG. 4.—GENERAL VIEW OF ENGINE ROOM, MANHATTAN RAILWAY POWER HOUSE.

relation of flywheel effect and torque or turning moment exerted upon the shaft by engine pistons, is uniform to an extraordinary degree. The revolving field, which is shown in Fig. 3, is 32 ft. in diameter, and in operation turns at 75 r. p. m., making its peripheral speed 7540 ft., or more than a mile a minute. Its weight is 370,000 lbs.

There are 40 field poles, built up of laminated steel. They are wound with copper strap on edge, one layer deep and the insulating material is cemented in place between the turns. The edges of the strap are exposed in order better to dissipate the heat developed. The normal exciting current for each alternator field is approximately 225 amperes at 200 volts, and the winding is so designed that the excitation can be increased to care for an overload of 50 per cent and a 90 per cent power factor. The field windings are held upon the poles by copper wedges driven between the pole tips. These wedges also serve to preserve constant the wave-form generated.

The armature, of which a section is shown in Fig. 5, consists of six castings bolted together, to which is attached the armature core. The latter is a built-up ring composed of thin, soft steel plates with slots on the inner surface, in which are placed insulated coper bars, con-

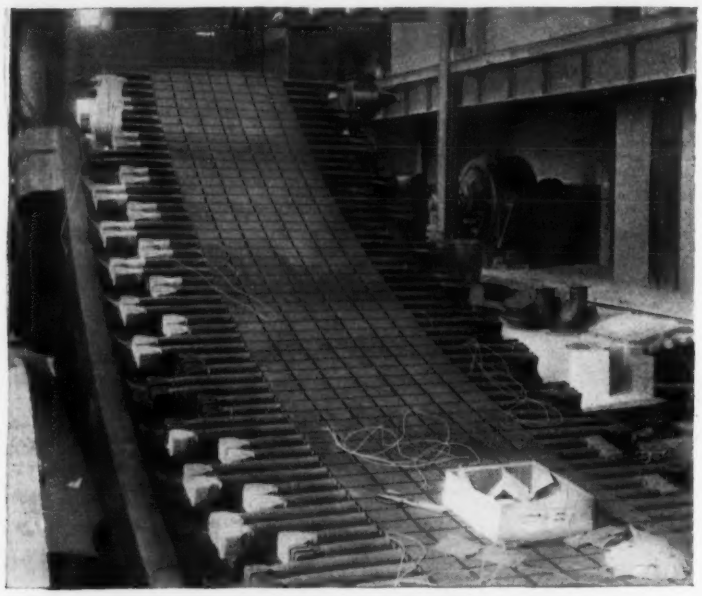


FIG. 5.—A SECTION OF THE STATIONARY ARMATURE.

stituting with their end connectors the armature winding. The steel plates are separated at intervals by ventilating spaces.

In order to produce a wave-form free from irregularities and of the same shape at different loads, a distributed winding with four armature slots per phase per pole was adopted. This tends to avoid the production of harmonics, which is an especially important matter in view of the large capacity and self-induction of an extensive system of cables and transmitting apparatus, especially where a large number of 1500-kw rotary converters are to be employed. Each slot contains three bars, which are securely fastened to the end connectors. The bars in any slot may be removed without disturbing the bars in the other slots and without moving the frame of the machine. The armature conductors are insulated to withstand a puncture test of 25,000 volts alternating current for 30 minutes.

The most important feature of the auxiliary plant at the power house is the exciter equipment. Current for exciting the fields of the alternators will be supplied by a battery of four 250-kw exciters, also furnished by the Westinghouse Company. These exciters are of the engine type, the armature and commutator of each machine being bolted together upon a ventilated cast-iron sleeve and pressed upon the engine shaft.

It is proposed also to install rotary converters and transformers at the central power station for furnishing current for operating motors, and the lighting plant. Altogether the lights and motor service from this plant irrespective of the car equipments will require as much current as many central stations in fair-sized cities.

In a following article the distribution system, including the rotary converters, will be described.

Complete Commercial Test of Polyphase Induction Motors Using One Wattmeter and One Voltmeter.

BY A. S. MCALLISTER.

THE ordinary factory or laboratory method of testing induction motors for performance and efficiency by direct measurement of the input, output, power factor, speed, etc., leaves little to be desired in cases where suitable testing apparatus is available. Even in such cases, however, the large number of instruments ordinarily required for testing is a source of objection, since each for accurate results must be properly calibrated and used without error in observation during a test. Obviously the less the number of instruments used in a test the less the liability for errors, except in such cases where one instrument may be used as a check upon another.

Outside of laboratories and the testing rooms of manufacturing establishments the number of instruments available for testing an induction motor is usually quite limited, in most cases including only ammeters, wattmeters and voltmeters, and seldom, indeed, any equipment for directly measuring the mechanical output. The desirability of reducing the requisite apparatus for a complete test is recognized by all. The suggestions offered herein are such as tend towards the elimination of all unnecessary apparatus.

The method of testing a transformer by separation of the losses is well known. Such a method, which by a few slight modifications can be applied to induction motors, is given below. Most of what is

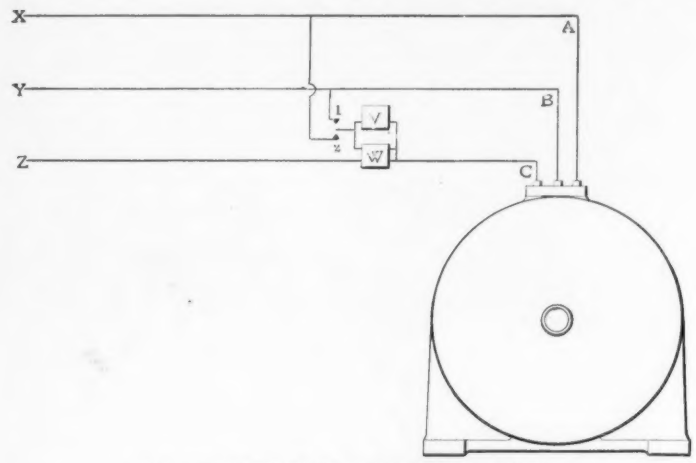


FIG. 1.—DISPOSITION OF TESTING CIRCUITS.

stated in this connection is true for any induction motor under any condition of service, though the greatest simplicity in testing and the requisite use of the least number of instruments will be obtained only with polyphase motors operating on well balanced and regulated circuits. Each element of a test will below be treated separately.

Slip.—The determination of the slip of induction motor rotors by counting the r. p. m. of both generator and motor is open to many objections. If the two readings of speed be not taken simultaneously though the true value of each be correctly observed, when the speed of either is fluctuating the value of slips will be greatly in error. A slight proportional error in either speed introduces an enormous error in the slip. Where the generator is not at hand the above method obviously cannot be directly applied, and is applicable only when a synchronous motor is available for operation from the same supply system as the induction motor.

When the secondary current can be measured and the secondary resistance is known, the most accurate and convenient method for determining the slip is from the ratio of copper loss of secondary to total secondary output.

If we let I_2 be any observed value of secondary current, R_2 the secondary resistance and W_0 the output of the motor, then

$$\text{Slip} = S = \frac{I_2^2 R_2}{W_0 + I_2 R_2} = \frac{\text{Copper loss of secondary}}{\text{total secondary output}}$$

As a proof of this fact, consider the magnetism cut by the secondary windings to be of a strength which would cause to be generated E_2 volts in the windings at 100 per cent slip.

Let S be any given slip, W_s the total secondary watts, ϕ the angle of lag of secondary current, and $L_2 W_2$ the secondary reactance at 100 per cent slip, then

$$\frac{I_2^2 R_2}{W_0 + I^2 R_2} = \frac{I_2^2 R_2}{W_s} = \frac{I_2^2 R_2}{I_2 E_2 \cos \varphi};$$

$$I_2 = \frac{S E_2}{\sqrt{R_2^2 + L_2^2 W_2^2 S^2}} = \frac{S E_2}{R_2 \sec \varphi},$$

$$\text{and} \quad \frac{I_2^2 R_2}{I_2 E_2 \cos \varphi} = \frac{S I_2 E_2 R_2}{I_2 E_2 R_2 \cos \varphi \sec \varphi} = S$$

Since neither E_2 nor $L_2 W_2$ appears in the above equation, the relation is independent of the strength of field magnetism cut by the secondary windings and of the secondary reactance.

Torque.—The rotor torque can be ascertained with the highest degree of accuracy and facility from the ratio of secondary input to the synchronous speed, that is, the torque is expressed in pounds at one-foot radius by the following equation:

$$\text{Torque} = T = 7.04 \frac{W_p - L_p}{\text{syn. speed}}$$

where W_p is the total primary input; L_p the total primary energy losses, and the synchronous speed is in r. p. m.

If L_p includes the friction, T will equal the external rotor torque, while if L_p includes only the true primary iron and coper losses, T will be the total rotor torque.

To prove the above expressed relation, let W_s be total secondary input, W_0 the motor output, and s the rotor slip. Then

$$T = 7.04 \frac{W_0}{\text{r. p. m.}};$$

but $W_0 = W_s (1 - s)$ and r. p. m. = synchronous speed $(1 - s)$.

Therefore,

$$T = 7.04 \frac{W_s}{\text{syn. speed}}.$$

Therefore, for a given primary input and primary losses the rotor torque is independent of secondary speed or output, and any error in the determination of either of the latter quantities need not affect in the least the value obtained for the torque.

If the total energy received by the secondary is used up in the secondary resistance the equation for the torque will be

$$T_s = 7.04 \frac{I_2^2 R_2}{\text{syn. speed}},$$

or starting torque, which, as is well recognized, may be increased by any method which will increase the stationary secondary copper losses.

Resistance of Squirrel Cage Secondary.—Due to the inability to insert measuring instruments in the secondary of squirrel-cage induction motors, the ordinary direct-current method of determining the resistance cannot be used.

If the rotor be clamped to prevent motion a wattmeter placed in the primary circuit will read the copper loss of both primary and secondary when the e. m. f. across the leads is reduced to give a fair operating value of primary current. If from the reading of watts thus obtained there be subtracted the known copper loss of the primary for the current flowing, the value of the secondary copper loss will be secured. The resistance of the secondary (reduced to primary) will be obtained by dividing this loss by the square of the primary current.

Secondary Current.—When the motor has a squirrel cage secondary winding, measurement of the secondary current cannot be made directly, but the determination of its value must be by calculation. The variation in value and phase of the primary current may serve as an indication of the current flowing in the secondary windings, though the actual increase in primary current does not represent the increase in secondary current.

The difference between the power components of the primary current at no load and under a chosen load equals the equivalent increase in the power component of the secondary current under the same conditions, while the difference between the quadrature components of the primary current at the same time is a measure of the equivalent increase in the quadrature component of the secondary current.

When the no-load value of secondary current is negligible the vector sum of the above-found components represents the secondary current for the chosen load in terms of the primary current.

5-HP, 8-POLE, 110-VOLT, 60-CYCLE, THREE-PHASE INDUCTION MOTOR. PERFORMANCE TEST. INSTRUMENTS: ONE WATTMETER, ONE VOLTMETER.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
OBSERVATIONS.	Primary E. M. F.	Primary Watts. W_1	Primary Watts. W_2	Total Primary Input, W_p. $\sqrt{3} I E \cos\theta$	$I E \sin\theta$	$\tan\theta$	Primary Angle of Lag. θ	Power Factor. $\cos$	$\sin\theta$	$I \sin\theta$	Primary Amperes Per Lead. I	Total Primary Amperes. $\sqrt{3} I$	Quadrature Component Primary Current. $\sqrt{3} I \sin\theta$	Primary Copper Loss. $3 I^2 R / 2$	Iron and Friction. *Fixed Loss*	Total Primary Losses With Friction L_p	Secondary Input Synchronous Watts. W_s	Rotor Torque. T	Power Component Secondary Amperes. $I_2 \cos\theta_2$	Wattless Component Secondary Amperes. $I_2 \sin\theta_2$	Total Secondary Current. I_2	Secondary Copper Loss. $I_2^2 R_2 / 2$	Motor Slip. S	Motor Output Watts. W_0	Motor Horsepower. HP	Motor Efficiency. %	Motor Speed. %
			(3)	(2) + (3)	(2) − (3)												(4) − (17)										
		−430	300	1140		6.58	81° 20′	.151	.989	10.3	10.4	18.0	17.8	35	275	300											
		−300	500	1100		3.81	75° 20	253	.967	10.0	10.38	17.95	17.3	25	275	300											
		− 200	800	1200		2.60	69°	.358	.934	10.9	11.7	20.3	18.9	32	275	317											
		150	1550	1250		1.39	54° 20′	583	.812	11.4	14.0	24.3	19.7	45	275	320											
		350	1950	1250		1.11	48°	.669	.743	11.4	15.4	26.7	19.7	55	275	330											
		680	2680	1320		.854	40° 30′	.760	.649	12.0	18.5	32.1	20.8	79	275	354											
		1130	3730	1470		.683	34° 20′	.826	.564	13.4	23.8	41.2	23.2	132	275	407											
		1400	4550	1750		.667	33° 40′	.832	.554	15.9	28.7	49.7	27.5	191	275	466											
		1580	5100	1940		.659	33° 25′	.835	.550	17.6	32.1	55.6	30.5	238	275	513											
		1900	6500	2500		.666	33° 40′	.832	.554	22.8	41.2	71.5	39.5	394	275	669											
		2000	6800	2600		.666	33° 40′	.832	.554	23.4	42.2	73.0	40.5	410	275	685											
		2600	8000	3000		.666	33° 40′	.832	.554	27.3	49.5	85.8	47.5	567	275	842											
		3150	9600	3600		.666	33° 40′	.832	.554	32.8	59.4	103.0	57.0	815	275	1090											
		3520	10800	4000		.666	33° 40′	.832	.554	36.4	66.0	114.0	63.2	1010	275	1285											
		4600	14000	5200		.666	33° 40′	.832	.554	47.5	86.0	149.0	82.5	1720	275	1995											

Primary Power Factor.—For a single-phase motor the determination of the primary power factor will usually involve the measurement of primary watts, volts and amperes.

For two-phase motors with equal e. m. f.'s across the separate phases, one wattmeter alone may be used to obtain the power factor by simply transferring the pressure coil from one phase to the other, leaving the current coil always in one lead. The reading of the wattmeter in one case will be $W_1 = I E \cos\phi$, and in the second case, $W_2 = I E \sin\phi$; whence $\tan\phi = \frac{W_2}{W_1}$, from which may be obtained the power factor.

For three-phase motors one wattmeter can similarly serve to indicate the power factor. The wattmeter readings will be $W_1 = I E \cos(\phi - 30)$; $W_2 = I E (\cos\phi + 30)$, whence $\tan\phi = \sqrt{3}\,\frac{W_1 - W_2}{W_1 + W_2}$.*

Primary Current.—If the primary e. m. f. watts and power factor

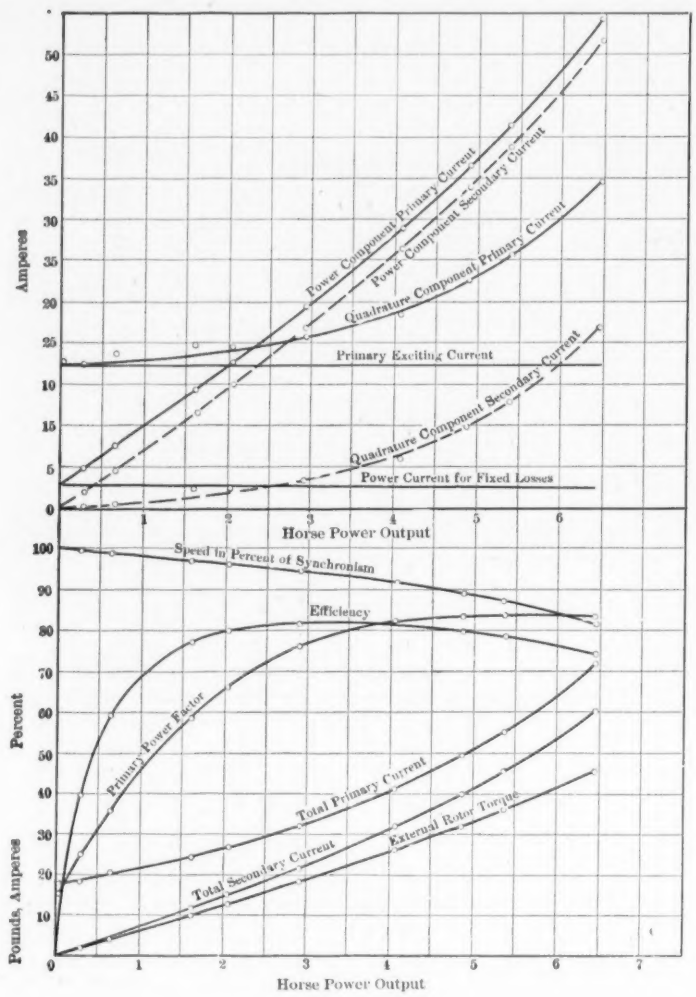


FIG. 2.—TEST CURVES.

be known, the primary current can readily be calculated and, therefore, need not be measured.

It is evident from the above discussed facts that with two and three-phase induction motors operated from circuits having constant and equal e. m. f.'s across the separate phases, one wattmeter and one voltmeter can be used to determine primary watts, amperes and volts, and secondary amperes, and that when the primary resistance is known or can be measured the complete performance efficiency, etc., of the motores can at once be calculated.

Below there is given the log orithmic calculations and curves of such a test made upon a 5-hp, eight-pole, 60-cycle, three-phase induction motor. The primary resistance between leads at running temperature was .155 ohms, equivalent to a secondary resistance of .56 ohms.

Since the copper loss of three-phase receiver is expressed by the equation, $\sqrt{\frac{3}{2}}\,R I^2$, where R is the resistance between lines and I is the current flowing in each lead, for either star or delta-connected receiver no attention need be paid to the method by which the primary coils are interconnected within the motor or, in fact, whether the secondary be wound delta, star or squirrel cage.

Tests made upon this same motor by the output-input methods agree throughout the whole range of the test with the herewith recorded test within the limits of the inevitable errors of observation of the various instruments used in the tests.

*See ELECTRICAL WORLD AND ENGINEER, Nov. 23, 1901.

Electric Gas Lamps and Gas Electrical Resistance Phenomena*.

BY PETER COOPER HEWITT.

ON a former occasion I had the honor of showing to the members of the Institute lamps utilizing the conductivity of gas for illuminating purposes, including experiments illustrating certain laws of conductivity of gases, and I also presented curves directing attention to various characteristics. It gives me pleasure to-night, while showing lamps in operation lighting this room, to describe some of the phenomena exhibited by the lamp and to indicate some of the difficulties encountered in determining the relative values of the resistances therein.

The mercury gas lamps exhibited to-night are operated on the standard Edison 118-volt direct-current circuit installed in this building; lamps of this class consume amounts of current varying from 1 to 6 amperes, and the energy is approximately ½ watt per spherical candle-power. Under better conditions as high an economy as ¼ watt per spherical candle-power has been obtained, determined by careful and accurate measurements. Measurements were made by measuring sections of the lamp varying in length from ¼ of an inch to 3 inches, shielding the lamp and leaving a slot in the shield of the length mentioned and measuring the light transmitted through the slot. These measurements have been made with lamps of various diameters. Dr. Max von Recklinghausen has made independent measurements, comparing the illuminating value of the lamps with incandescent lamps of equivalent rated candle-power, and the results of such tests agreed remarkably well with the mesurements obtained upon photometers.

I have made lamps with diameter of bore less than ⅛ of an inch and as large as 3 inches, and from less than 3 inches in length up to over 10 ft., giving from less than 10 candles up to fully 3000. Lamps of very small bores give more trouble in manufacture and operation than those of moderate size. Lamps of innumerable shapes and dimensions have been constructed and great variation of candle-power for various diameters obtained. There appears no reason why lamps may not be made of any size required and of any desired candle-power per inch within wide limits, the only limitation appearing being that imposed by softening of the glass when too many candle-power per inch are produced. The general rules established regarding their operation hold good in so far as examined, and it is possible to predetermine with almost absolute exactness the voltage, current consumption and candle-power of a lamp when the manufacture is perfect.

The light produced by pure mercury gas comprises orange-yellow, lemon-yellow, green, blue, blue-violet and violet; and although all shades of these colors may not be present, their absence would not be so seriously felt were it not for the absence of the red. For some purposes the lack of red in the spectrum is objectionable, but for many uses it is a positive advantage.

For shop work, draughting, reading and other work where the eye is called upon for continued strain, the absence of red is an advantage, for I have found light without the red is much less tiring to the eye than with it. It is possible to transform some waves of this light, especially the yellow light, into red light, and thus in a measure to overcome this defect where required for general indoor illumination. A moderate amount of ordinary incandescent light interspersed with the mercury gas electric light serves to supply the deficiency, and the mixture may be made most satisfactory. For ordinary street lighting purposes the mercury light is available even without the red, and it should be noticed that this light has very great penetrating power and seems to be effective through greater distances

*A paper read before the American Institute of Electrical Engineers, New York and Chicago, January 3, 1902.

than an equivalent amount of measured candle-power from the ordinary incandescent lamp. This may be due to the fact that the waves of the red light are less penetrating than those waves which are present in the mercury light, and hence the least valuable portion of the spectrum having such illuminating effects is omitted and the energy is practically expended in the more useful portions of the spectrum.

I have made lamps in which this color objection has been overcome, sacrificing on some occasions the extremely high light efficiency obtained in this particular lamp. Without doubt lamps of this type will be produced whose light will be even more beautiful than this light is objectionable; in fact, I have produced very beautiful and becoming light. Every gas gives its own particular spectrum when traversed by current, only part of which is visible, and that one having its spectrum richest in the visible portion is the most efficient for service as a lamp. Each develops its own color peculiarities and presents its particular electrode phenomena, chemical and physical, but I am convinced it is only a matter of patient work to render many gases practically available as light-giving media. When it is considered that this light, when obtained with mercury gas, has an efficiency at least eight times as great as that obtained by the ordinary incandescent lamp, it will be appreciated that it has its use in places where lack of the red is not important, for the economy of operation will much more than compensate for the somewhat unnatural color given to illuminated objects.

I would like to state some of the phenomena that had to be unraveled before it was possible to establish the laws governing the operation of electric gas lamps. The conductivity of the gas of the lamp, which is the most important factor, is dependent upon the diameter of the gas column, the length of the gas column, the density of the gas in the column and the resistance factor of the particular gas; with these must be considered the resistance at and about the respective electrodes to obtain the total resistance presented by the lamp. In determining the relative values of these it was assumed that the resistance of the gas column would vary directly as the length; this has so far proved to be true. From the results of a great number of experiments, and from some particular ones, I was able to demonstrate that the resistance varied inversely with the diameter; not as a square, as in metallic conductors, but very nearly as the first power. It is very difficult to obtain identical surroundings for lamps of different diameters, and I am of the opinion that any discrepancy that occurs is due to difference of environment. I was able to demonstrate that the resistance varies inversely with the quantity of the current passed, which means that the lamp requires a constant voltage unless some change takes place. The voltage across the terminals of the lamp is modified by the density of the gas, a gas having a density of maximum conductivity or a certain definite amount of matter and molecular movement best suited for conduction. Beyond the point of maximum conductivity the resistance appears to increase absolutely directly with the density, but I wish to state that my means of measuring at these low densities were not sufficiently accurate. The density is an entirely controllable factor, and is one of the best means of controlling the voltage. The laws above stated appear to hold good as to gases, generally.

The electrode resistance at the positive, providing there is no alteration of the chemical or physical condition of the electrodes, may, from a practical standpoint, be regarded as being very slight and will be neglected for the present.

The negative electrode resistance offered very great difficulties and required long and patient experimental investigation. I found that it consisted of a variety of factors, and I will briefly direct attention to those which appear to have the more important bearing upon the operation of the lamp. There is a reluctance to the initial passage of current which appears as if self-created by the current—as if by induction. Upon increasing the voltage applied thereto, current passes to a very small extent and thereupon there is a fall in resistance. To increase this small amount of current the voltage must be still further increased. On further increase of current this resistance apparently ceases and there is an enormous decrease of voltage. This resistance apparently does not exist when chemical or physical alteration occurs at the electrodes.

When the last-named resistance is overcome by reason of passing current, a flame may be noticed proceeding from the negative electrode in a direction perpendicular to the surface from which it issues. If this flame meets the current in a right line, that is to say, projects in the direction of the flow of the current at the point of meeting, the total resistance of the lamp is materially greater than when the flame proceeds in a direction at an angle to the flow of the current.

When the flame is proceeding from the negative electrode at an angle to the line of the current, then the resistance at the negative electrode, under the conditions which are established is reduced, and practically speaking, the principal and controlling resistance of the lamp is then located in the gas-path proper.

The reluctance to starting is greatly modified by charging the surface of the lamp exterior to the negative electrode positively, and also in a less degree by dissipating the charge that collects there. It is for this reason that the lamps have a conducting band exterior to the negative. This resistance may also be modified by charging and discharging the lamp with a high-voltage current.

I may here add that these initial resistances to the passage of current may be overcome by an impulse of high potential, as by the discharge of a reactive coil.

Electrical relations, as well as chemical, exist between the various kinds of gases used and electrodes of different materials, so that the presence of some other matter, "foreign matter," may bring about a total change of conditions and phenomena which normally should exist at the negative electrode in a state of purity. These conditions give rise to new and unexpected phenomena, and phenomena of great importance are brought into existence at the positive electrode. In the practical manufacture of the lamp, when abnormal conditions arise, that is to say, when other phenomena than those above outlined appear, or those above outlined do not appear, it is customary to attribute them to the presence of "foreign matter."

From what has been stated, it will be seen that the problems, which had to be solved to produce a lamp, comprised, among others, not only the determination of the conductivity of the gas column, involving the relations of the length and diameter, but determining the relative values of the other different factors of the electrical resistances, resistance at the electrode, etc.; determining the conditions accompanying varying densities, the variations in the conductivity with respect to the amount of current flowing; also methods of finding a pure gas with stable chemical and physical conditions within the lamps, and also determinng the relations of the electrodes and gas with respect to each other under operating conditions.

In one experiment shown upon the former occasion referred to, the initial resistance to the passage of the current was illustrated and the electrical leak through this resistance was measured; but at that time no attempt was made to point out the several resistances or factors thereof which have been referred to above.

In some particular forms of lamp the resistance at the negative electrodes has been availed of to render the negative electrode itself a source of light. Such conditions were established that no physical or chemical change took place at the negative electrode, and it developed that the electrode could then be heated to any desired temperature. Iron electrodes under these conditions may be maintained at a very high temperature and give off considerable light, the electrode itself being then the chief source of light. I even succeeded in melting platinum and maintained it in a molten puddle.

I might mention an interesting negative electrode experiment where an ordinary lamp about 30 inches in length contained a rod of metal one-eighth inch in diameter, projecting from the mercury negative to an eighth of an inch of the positive electrode, which was located as usual, and a movable bridging piece permitted bringing this rod into electrical connection with the positive. On forming contact and breaking, the current shoots to the mercury negative, although the total resistance over the lamp requires 60 volts with about two amperes passing, while that of the rod was negligible with respect to ohms.

The presence of slight impurities in the lamp serves to vary the resistance to starting in a very marked degree. Under some conditions impurities or "foreign matter" facilitate conduction, whereas under other conditions "foreign matter" serves to greatly increase the resistance.

Referring again to the flame occurring at the negative which is present while the lamp is in operation, it may be stated that the direction of the flame is largely, if not entirely, independent of the direction of the current, and is determined by the plane of the surface receiving the current. The direction of the flow of the current to that surface is, generally speaking, through the shortest path from the positive electrode, so that if the entrance plane of the negative electrode surface be out of the perpendicular to the flow of the current, then the flame may be made to proceed in a direction out of the path of the current, and thus will not interpose its resistance to the current flow. In some of the types of lamps shown here to-night, the surface of the mercury constituting the negative electrode, as will be seen, does

occupy such a position with relation to the path of the current, and the flame proceeds in a line out of the path of the current. In some of the lamps, for the purpose of causing the position at which the current passes into the negative electrode to remain fixed and the flame regulated, the metal leading-in-wire is carried to a point at the surface of the mercury, and the path of the current once being fixed upon this point, remains there instead of wandering about the surface of the mercury, the current entering the meniscus. The flame may be deflected and its position controlled by the use of a magnet when so desired. Where no point is used there is a tendency for the current to wander and burrow, as it were, into the body of mercury. This results in temporary depressions, so that the flame may proceed from the walls of these depressions in a direction at an angle to the direction taken by the current, but the wandering of the current about the surface of the mercury will necessarily cause a constant shifting of the direction of the flame and cause variation in the resistance of the lamp.

I have used other gases than the vapor of mercury as the gas-path, but mercury is more convenient for general experimental investigation for many reasons, among them the fact that as a negative electrode, its resistance is stable; the readiness with which the alteration of its condition may be brought about; the high efficiency of a mercury gas as a light-giving medium, and also the fact that it can easily be obtained in a fairly pure state.

"Illumination" Discussion Before the Institute.

"Illumination" furnished the topic for the meeting of the American Institute of Electrical Engineers held in New York and Chicago Jan. 3. This meeting, according to the regular schedule, would have been held the last Friday in December, but as this date fell in the holiday week it was deferred to Jan. 3. Six papers were read before the meeting, of which we print two in full elsewhere in this issue—that by Mr. Peter Cooper Hewitt on mercury vapor lamps, and the paper by Mr. Clayton H. Sharp on the advantages of the acetylene-oxygen flame for use as a primary photometric standard. The other papers, of which abstracts are given below, were presented by Dr. Louis Bell, Mr. John W. Howell, Mr. S. Everett Doane and Mr. W. D'A. Ryan.

Dr. Bell discussed the subject of illumination in its general and practical aspects rather than with relation to the technical details of electrical lighting. He considers that the three most important qualities for a practical illuminant are, in their order of importance, as follows: Steadiness, suitable intrinsic brilliancy and suitable color. The importance of steadiness cannot be overestimated, for without it in a rather high degree, an illuminant is both impracticable and dangerous to the eye. Eyes differ in sensitiveness, but a variation of 10 per cent with some is annoying and trying. Assuming the constant or retinal persistence to be one-fiftieth second, a 10-per-cent falling off in brilliancy would correspond to about one-fiftieth second, and one is safe in saying that sudden flashes one-fiftieth second apart would cause trouble at once, and probably, owing to frequent recurrence, very serious trouble. An alternating arc worked with small current density gives such succession of flashes, and instead of a certain amount of thermal stability, would be quite impossible at a frequency of 25 cycles, and is bad even at a frequency of 100 cycles per second. Since incandescent lamps have a greater thermal stability, they present smaller fluctuations due to frequency, but are very bad at 15 to 20 cycles, and show fluctuations troublesome to some eyes up to and even about 35 cycles. In conclusion, Dr. Bell considers that any source of light subject to rapid and frequent variations as great as 5 per cent is unfit for use as an illuminant for work requiring steady use of the eyes.

As to intrinsic brilliancy, the brightness of the radiant used in artificial lighting is a matter of great physiological moment. The fundamental rule of proper illumination is to keep brilliant radiants out of the field of vision. The real criterion of visual usefulness is not the illumination, but the product of this by a factor dependent upon the effect of the aperture of the iris. A criterion to be applied is illumination divided by a constant referring to the intrinsic brilliancy of the retina. The comparative values of this constant as given by L. Weber are as follows: Horizontal white card, brilliant sunlight, 25; white sunlit cloud, 7; Argand burner, 6.25; horizontal white card, dull winter day, .26. Dr. Bell concludes that for radiants within the field of vision at the distance ordinarily met with in interior lighting, a value of 5 is about as high as it is wise for hygienic reasons to go. With proper diffusion, the entire globe surface may be taken as radiant, and for a first approximation the radius of a spherical diffusing globe should be at least

$$r = \frac{C.\ P.}{5\ \pi}$$

C. P. being the candle-power.

As to color, it is the orange, yellow and green that make up the working luminosity of the spectrum formed by sunlight, to the extent of about 80 per cent, and even were a brilliant deep blue or red light produced it would require far greater energy for the same luminous effect than the yellow or greenish light. The eye unquestionably does its best work by light approximately like that through which it has been evolved—sunlight. The ideal artificial light, from a purely utilitarian standpoint, should resemble average sunlight.

Dr. Bell divides classes of illumination into general and directed, and draws a distinction between light intended to be generally diffused and light intended to facilitate particular operations at particular points. By skilfully treating illumination, superior results may be produced with a saving of energy. There are two criteria for judging sources of light—illumination and intensity. The former is an extremely difficult thing to measure with precision, as there may be 10 per cent or more error, and the instruments are subject to peculiarly large personal errors. Dr. Bell considers that to judge commercial illuminants as far as quantitative relations are concerned, intensity measurements should be used, qualitative relations being left to consideration on their merits.

Under the head of "Intensity of Illuminants" the several more important sources of light are discussed. The Hefner-Alteneck lamp is stated to be quite accurately reproducible and fairly steady, but is open to the objection that it is of very small intensity and of extremely bad color. Dr. Bell considers that the Vernon-Harcourt pentane standard is worthy of respectful consideration.

As to units, that which has the greatest importance in a practical way is the unit of luminous flux called lumen. The conception of light outflowing from the center and of all available light as quantity, based upon this conception, Dr. Bell considers to be a most useful one. The total light given by any radiant must evidently be expressed in some such way as this in order properly to take account of its sometimes very great variations in different directions. The total luminous radiation is an important scientific problem, and the main spherical intensity is the only ground in common upon which all can stand. Dr. Bell states that as chairman of the committee of the National Electric Light Association for the rating of incandescent lights, he has wrestled for the last five years with the intricate and annoying problem of finding for commercial convenience, if possible, some reliable and simple method of applying a common test to radiants differing even so little in distribution as do incandescent lamps; after canvassing the whole question and examining a vast amount of data on the subject, and after struggling to escape all the details of the somewhat intricate mean spherical measurement, he is compelled to fall back upon it as the court of last resort in matters of illumination.

The paper presented by Mr. W. D'A. Ryan consisted mostly of an argument in favor of the alternating-current arc lamp for street illumination as against the open arc, incandescent lamp and the direct-current enclosed arc. The conclusions of Mr. Ryan are as follows:

First.—Open arcs give a higher maximum candle-power than enclosed arcs of corresponding wattage, but the maximum candle-power is in an undesirable direction and the light fluctuates through wide limits. Enclosed arcs give a higher candle-power through the most useful angle from, say, 3 to 10 degs. below the horizontal. The light from the enclosed arc is more uniform and steadier and generally superior from an illuminating point of view to open arcs.

Second.—Direct-current enclosed arcs produce slightly higher candle-power than alternating-enclosed arcs of corresponding wattage, but so far as the illuminating value is concerned the two lamps are on a fair basis of equality, both being superior to the direct-current open arc.

Third.—Small unit arcs will illuminate proportionately greater distances than large units for a given expenditure of energy.

Fourth.—Incandescent lamps do not illuminate brilliantly to a sufficient height above the street surface to produce the effect of good lighting and are, therefore, not comparable with arc lights.

Mr. John W. Howell read a paper entitled "The Incandescent Lamp of To-day," in which he considered the subject in relation to the topic of the meeting. He referred to the adaptability of the incandescent lamp to any system of electrical distribution, there being no difference in its operation on direct or alternating current, provided the latter has a frequency of 25 cycles or more per second.

Two kinds of carbon are used in making filaments, and the best results require the proper combination of the two kinds. The specific resistances of these two kinds of carbon limit the voltage of lamps of a given candle power and efficiency in which this proper combination can be made. Lamps for a higher voltage than will permit the proper combination of the two kinds of carbon may be made with less of the graphitic coating which has a low specific resistance, or entirely of the base carbon; but in either case the lamp should be operated at lower temperature to give equally good life and candle-power results. The best results are obtained with lamps of not higher than 120 volts; 250 volts are now regarded as the maximum desirable voltage, and at this point there is an increase of about one-half a watt per candle for equally good results.

The economy of an incandescent lamp depends upon the temperature of the filament—the higher the temperature the better the efficiency and the shorter the life. Lamp economies are usually stated in watts consumed per horizontal candle. The commercial limits are between 2½ and 4 watts per English candle, or about 120 per cent of these figures if spherical candle-power is considered, the 2½-watt lamps being used where electricity is expensive and regulation good, and the less efficient lamps where electricity is less expensive or regulation is not so good, or where other considerations demand a longer useful service from the lamps.

The color of the light from an incandescent lamp depends entirely upon the temperature of the filament; the higher the temperature the more nearly white the light becomes. The color of the light generally is yellow. Weber observed that the first visible radiations from a filament as it was heated came not in the red region of the spectrum, but in the yellow region, where the maximum radiation occurs when the lamp is at high temperature. Dr. Nichols observed that carbon has a selective radiation in the yellow region of the spectrum, the radiations there increasing faster than radiations in the other parts of the spectrum.

The use of higher efficiency lamps is becoming quite general. Very few 4 w. p. c. are now used for multiple lighting, while a few years ago no lamps of less than 4 w. p. c. were sold. This is due to the improvement in quality of the lamps and also to better regulation of current. High efficiency lamps are more satisfactory than low. The filament being smaller, the bulbs blacken less and being hotter they break before reaching very old age. Low candle-power lamps are also coming into more general use. The demand for these has increased very considerably in the last two or three years. The use of lamps for decorative effects and for special work of various kinds has increased the usefulness of the lamp and added to its popularity.

Mr. S. Everett Doane, in a paper entitled "Some Common Faults in Exterior Illumination," pointed out objectionable features in the use of high-intensity outdoor illuminants, such as high-power arc lamps, and make a plea for the use of the incandescent lamp for exterior illumination.

In answer to the question, Why, with all its drawbacks, the arc light is used almost universally and incandescent lamps to so limited an extent? Mr. Doane says he thinks there will be no discussion as to the reason. Incandescent lamps for street lighting have always been difficult to make and less satisfactory than other types of incandescent lamp. The ordinary 100-volt to 125-volt 16-cp, 3.1 watts per candle, incandescent lamp gives more candle-hours for a given input than any other incandescent lamp. Could this lamp be used for street lighting the cost of street lighting by incandescent lamps could be materially reduced and the service rendered be much more satisfactory to the user of the highway.

There are many streets in which low-voltage mains run the length of the streets, and where these lamps could be used in multiple with no inconvenience. There are many other streets where 10 or 20 could be used in series, each on a cut-out box, no more complicated than the Nernst lamp. These cut-out boxes would not be so complicated as the arc lamps, which operate with practically no attention.

At present, the arc lamp lines are no longer the only wires on the poles. Probably one-half of the electric lighting poles carry alternating current mains also. Incandescent lamps are now universally fastened to their bases by a waterproof cement, and waterproof sockets are in stock everywhere.

The arc lamp has its use in street lighting. There are places where it is wisest to use it. The public think they are getting more for their money with the brilliant arc lamp, but Mr. Doane believes that as the users of the highways come to appreciate how much safer and more satisfactory is well-placed incandescent illumination, we shall learn to light our streets as well as our homes.

For a given expenditure of energy, more light can be actually delivered to a highway by incandescent lamps than by arc lamps, and it can be better distributed. Arc lamps are at their best in densely settled districts. The reflected light from buildings helps to economize the distribution, and the great quantity of light from store windows also assists to so brighten the surroundings that the arc light is less blinding. Arc lights are also more closely spaced in these localities, which is to their advantage. It is the opinion of Mr. Doane that incandescent lamps are much to be preferred for residential streets, side streets and outside the more congested portions of a town or city.

The Present Status of the Question of a Standard of Light.*

BY CLAYTON H. SHARP.

THE situation as regards a standard of luminous intensity has shown in recent years a marked tendency towards simplification and unification. A number of standards or would-be standards, which were formerly taken seriously, have disappeared from practical use. Of the various candles, the British candle is the only one which survives, and the practical use of it is steadily decreasing. The Carcel lamp is held in much less esteem than formerly. Practice is settling down to the selection of one of two classes of standard, either the pentane standard in one of its forms, or the Hefner amyl-acetate lamp.

The small 1-cp and 1½-cp pentane lamp has proven itself worthy of confidence as a result of thorough investigation in the Reichsanstalt. The 10-cp pentane lamp is coming into very extensive use by the gas men here and in England, and commends itself by its simplicity of operation, by its relatively high intensity and, as far as is known, by the constancy of its indications. Unfortunately, there is on record no such careful investigation of its properties in this particular as has been made for the smaller pentane lamp and the Hefner lamp.

If gas practice is looking more and more to the pentane standard, electrical practice is looking towards the Hefner lamp. The careful study made in the Reichsanstalt, the adoption of it officially in Germany, the resolutions in its favor by this Institute and by the Geneva Congress of 1898 have served to popularize it and to intrench it strongly.

While the facts enumerated show that great progress, it is not to be assumed that a satisfactory solution of the problem of a standard has been reached. A standard must be as nearly as possible a common denominator of the sources of light in ordinary use. No one integrated source of light can be in all strictness a common denominator for all, on account of the existing differences in quality or color. That light most nearly fulfils this condition which most nearly approaches in color the average color tone of the sources of light in use to-day. Now this is much higher than it was a few years ago, due to the extensive introduction of whiter hued sources of light. The standards referred to above stand, as far as color is concerned, about at the bottom of the list, and from this point of view are as bad as possible. Photometric comparisons with them of most modern lights are very uncertain and the results are misleading in that they do not give to the whiter sources credit for the greater visual acuity per candle-power which is their due.

It follows that a standard of light of considerably whiter hue than the present ones would be intrinsically better if of equally good qualities in other respects, and it is towards the definition of such a standard that efforts should be directed.

Quite a good deal has already been done in this line. A notable advance has been made by Petavel[1] in his investigation of the Violle platinum unit. He has indicated the precautions which must be taken to secure good results, and has demonstrated that the limits of error may be made quite narrow. The color of this standard is quite good. Violle has stated that it is very similar to that of the

*A paper read before the American Institute of Electrical Engineers, New York and Chicago, January 3, 1902.

[1]Proc. Roy. Soc., Vol. LXV., p. 481, 1900.

acetylene flame, but this statement does not seem to be entirely consistent with the known fact that platinum can readily be fused in the acetylene flame.

The studies by Paschen and by Lummer of the theoretically "black" body has indicated a method by which a perfectly definite radiating surface can be secured, and it needs only a sufficiently accurate method of defining the temperature of such a surface to give us a standard of light. Since, however, the luminous radiation from such a surface increases as a high power of the temperature, a sufficiently accurate method of temperature definition cannot easily be found.

Among the ordinary sources of light, the acetylene flame probably approaches most nearly in color to the average hue. The ease with which this gas can be produced in a good degree of purity and the steadiness and manageability of its flame also commend it for use as a standard. Violle,[2] Fessenden[3] and Féry[4] have made independent propositions to this end, but no definite standard has yet been the outcome.

Fessenden showed how a stable flat flame can be produced with this gas employing the method of the converging jets now in common use. He found the flame to be very steady and moderately immune from outside influences. Such a flat flame, with the light from its edges screened off, has been used very successfully by Professor Nichols[5] in his spectro-photometric investigations of the radiation of carbon. The flame was controlled by measurements of the pressure of the gas.

The proposition of Féry looked to the use of a long, slender flame. He used a bit of thermometer tubing of internal diameter of 0.5 mm. as a jet. With this he found that the luminous intensity of the flame was proportional to the flame height between the limits of 1 cm. and 2.5 cm., that is, he substituted for control by pressure measurements, control by measurement of the flame height.

What is now known of the properties of the acetylene flame indicates that a search for the best method of producing and defining an invariable acetylene flame would be fruitful of valuable results.

It has been proposed to employ as a standard flame one in which a pure gas burns under standard conditions in a pure atmosphere, both of known chemical composition. A practical method of burning pure acetylene in an atmosphere of pure oxygen has been found, as well as direct and interchecking methods for the control of such a flame, but the investigation has not led to any definite result.

Until a more satisfactory standard is introduced, photometrists are practically limited to the choice of either a pentane standard or the Hefner lamp as primary standards. An incandescent lamp carefully seasoned and measured furnishes for most purposes a thoroughly satisfactory secondary standard, and we are looking forward to the time when the National Standardizing Bureau will establish an authoritative standard and will measure and will certify to lamps sent to them for this purpose.

Boston Elevated Railway Company.

With regard to the plant of this company, which includes the West End surface system, President Bancroft states in his annual report that during the year the company increased its motive power by putting into service two new engines of large size, each of 4050 hp, operating a 2700-kw generator, at the Lincoln power station. Provision has been made for two other engines and generators of corresponding size, one at the Lincoln power station and one at the Charlestown power station. When these are installed, the company will have a motive power of 55,316 hp or 36,944 kw, at normal capacity, capable of sustaining an overload of 15 per cent for hours, of 5542kw in addition, so that under stress the generators ought to supply power to the amount of 63,612 hp. The use of horses as the motive power for street cars was given up by the company on Dec. 24, 1900. Horses had been used to draw cars for nearly 45 years.

Municipalization at Worcester, Mass.

The committee of the Worcester Common Council appointed to investigate the purchase of the local lighting company has now reported adversely. A very thorough study of the question was made, and the committee quotes a number of plants to show that the city could not better the service, and prices it is now enjoying from the company, some 17 cities being taken into consideration.

[2] *Comptes Rendus*, Vol. 122, p. 79, 1896.
[3] *Trans.*, A.I.E.E., Vol. XII., p. 500, 1895.
[4] *Comptes Rendus*. Vol. 126, p. 1192, 1898.
[5] *Physical Review*. Aug. and Oct., 1901.

American Institute of Electrical Engineers.

FIG. 1.—TUBE AT DOORWAY.

A MOST successful meeting of the Institute was held in New York City on Jan. 3, starting off the new year very auspiciously, the general subject for discussion being methods of illumination and units of light. A number of papers were presented, of which note is made elsewhere in this issue. At least 250 members were present during the evening, and great interest was aroused by the display of tube lighting by Mr. Peter Cooper Hewitt, who had on view and in operation six of his ordinary mercury vapor lamps. One of these suspended vertically over the main entrance, was an object of great curiosity to the passers-by, its gleaming white light being visible at a great distance. We have endeavored to present a view of it here, the dim lights seen below it being the incandescents on each side of the steps.

Within the building the main meeting room was lit with five of the mercury arc tubes, as shown in one of the cuts herewith, one being hung vertically and the other four being bracketed horizontally around the sides of the library gallery. At times these were burned in company with the regular incandescents, but they were also run separately, and were in continuous use throughout the evening from 8 until 11 P. M., and longer. It will be remembered that Mr. D. Mc-

FIG. 2.—PRESIDENT STEINMETZ.
(*Exposure of about 12 seconds.*)

Farlan Moore also has illuminated the same large room with his vacuum tubes, so that it is becoming quite historic for experiments of this kind. The picture we show of the tubes themselves is virtually an instantaneous photograph. The fine portrait of President Steinmetz was taken in about 12 to 15 seconds' exposure, and the result is very striking, as to its sharpness of definition, the photograph showing clearly the little vibration of the presidential cheroot when Mr. Steinmetz took a new bite on it as he called the meeting to order. The view of the other end of the room was of about equal

exposure, and is not less sharp in its outline. Our photographer, who takes many thousand views a year for this and other public prints, remarked that the light, while very deficient in red rays, was remarkably revelatory and seemed to him to "get in under the surface" like the Röntgen ray, and he could only compare it with daylight. The tubes were run on the regular direct-current Edison system, with the starting devices grouped on the platform. Mr. W. J. Hammer used the same devices to show up one or two of Mr. Edi-

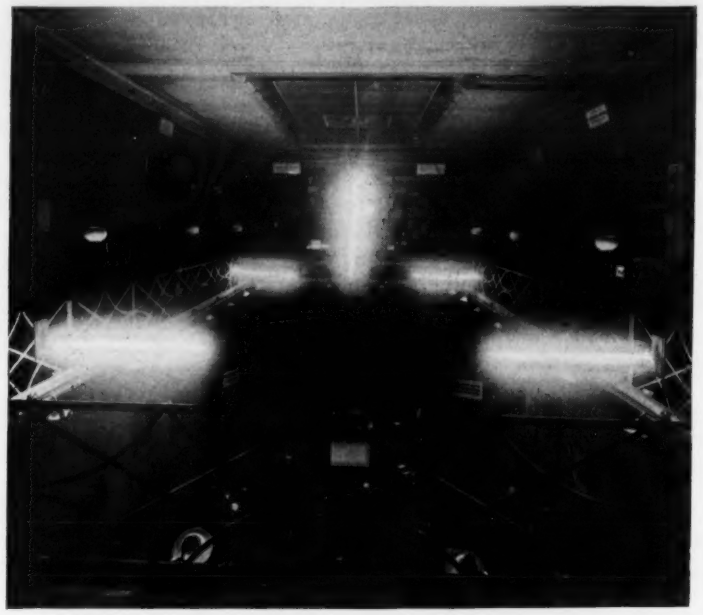


FIG. 3.—VIEW OF MEETING ROOM AND HEWITT LAMPS.
(Practically Instantaneous.)

son's fluorescent tubes, and exhibited also the weird effects of "radium," of which he had an infinitesmal quantity in a tube. In the dark, unexcited, the radium showed with curious phosphorescent gleam, and when the tube was wrapped by Mr. Hammer in cotton wool the whole mass—tube, wool and all—took on the same firefly glow.

At the council meeting in the afternoon the following were duly elected to associate membership:

Amstutz, Noah Steiner, Amstutz Osborn Company, 27 Hillside Avenue, Cleveland Ohio; Armstrong, Samuel George, 1 Kimberley

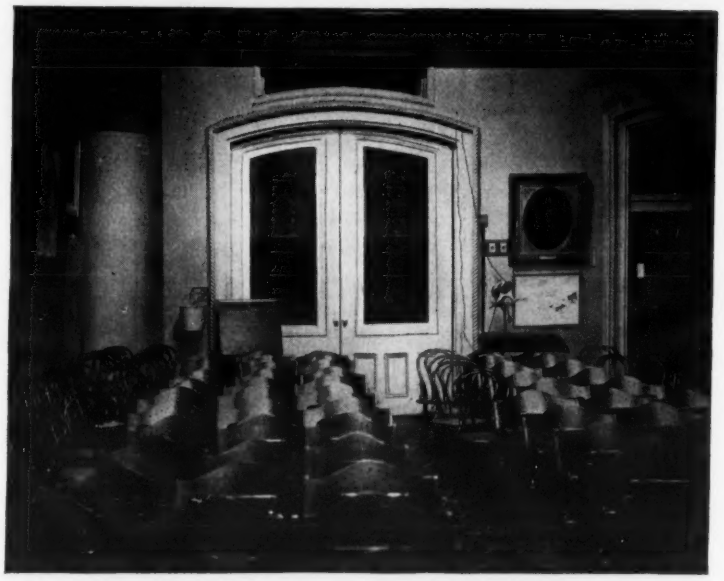


FIG. 4.—VIEW OF REAR OF ROOM TAKEN BY LIGHT FROM HEWITT LAMPS.
(Exposure of about 12 seconds.)

Villa, Harrington Street, Cape Town, South Africa; Arnold, Chester Hastings, Assistant Engineer New York Telephone Company, 18 Cortlandt Street, residence 241 East Eighteenth Street, New York City; Averrett, Andrew E., engineer, General Electric Company, Schenectady, N. Y.; Erwin, Frank Bennett, demonstrator, Federal Instrument Company, 293 Clinton Avenue, Albany, N. Y.; Estes, Orange A., Central Union Telephone Company, Akron, Ohio; Everit, Edward Hotchkiss, superintendent of equipment, The So. N. E. Telephone Company, 641 Whitney Avenue, New Haven, Conn.; Ferguson, Samuel, engineer, General Electric Company, Schenectady, N. Y.; Fitzgerald, Thomas, Jr., superintendent, F. C. E. R. R. Company, Fairmount, W. Va.; Gray, Edward Wyllys Taylor, manager, New York sales office, Westinghouse Electric & Manufacturing Company, 120 Broadway, New York City, residence Montclair, N. J.; Hanks, Marshall Wilfred, engineer, Nernst Lamp Company, residence Amber Club, Pittsburg, Pa.; Henry, George Clinton, assistant to president, The Johnson Law Company, 51 West Forsythe Street, Jacksonville, Fla.; Herzog, Josef, chief of installations department, Ganz & Co., V. Elisabetplatz 1, Budapest, Hungary; Hillman, Harry W., General Electric Company, Schenectady. N. Y.; Hutchinson, Rolin William, Jr., student, Polytechnic Institute, residence 302 Clinton Street, Brooklyn, N. Y.; Kerr, Samuel Ross, foreman in testing department, Triumph Electric Company, 610 Baymiller Street, residence 616 West Eighth Street, Cincinnati, Ohio; Kershner, Jefferson E., consulting engineer, The Lancaster R. & L. Company, Lancaster, Pa.; Kline, James Joseph, engineering student, Stanley Electric Manufacturing Company, residence Beech Grove Inn, Pittsfield, Mass.; Lamb, Francis Joseph, electrical engineer, Lamb & Co., corner Kent and Lyon streets, Grand Rapids, Mich.; Layton, Gordon, electrical engineer, British Westinghouse E. & M. Company; residence 48 Lancaster Park, Richmond, England, 327 Pitt Street, Wilkinsburg, Pa.; Maxim, Hiram Percy, engineer, vehicle motor department, Westinghouse E. & M. Company, Pittsburg, Pa.; McCarthy, Albion Fuller, inspector New York Edison Company, 23 Manhasset Place, Brooklyn, N. Y.; Newell, Frank Clarence, consulting electrical engineer, Westinghouse Air Brake Company, residence 526 Wallace Avenue, Wilkinsburg, Pa.; Pratt, William Hemmenway, designing engineer, General Electric Company, residence 60 Eastern Avenue, Lynn, Mass.; Ramson, Allen Edward, engineer and salesman, W. E. & Mfg. Company, 314 Occidental Avenue, Seattle, Wash.; Reilly, Harry Winne, J. G. White & Co., Monroe, Mich.; Shuster, John Wesley, instructor in electrical engineering, University of Wisconsin, residence 18 East Dayton Street, Madison, Wis.; Szuk, Geza, chief engineer, Ganz & Co., residence Csalogany utcza 52 Budepast II, Hungary; Taylor, Frank H,. Westinghouse Electric & Manufacturing Company, residence 7422 Penn Avenue, Pittsburg, Pa.; Treat, Robert Belden, electrical engineer, Crocker-Wheeler Company, Ampere, N. J., residence 43 South Tenth Street, Newark, N. J.; Vankirk, Edward Power, electrical engineer, Westinghouse Air Brake Company, Elizabeth, Pa.; Webster, Walter Coates, assistant to fourth vice-president, Westinghouse Electric & Manufacturing Company, 120 Broadway, New York City; Whittemore, George W., engineer, Bell Telephone Company, residence 24 W. Seneca Street, Buffalo, N. Y.; Zurfluh, William Nicholas, superintendent, Home, Light, Power & Heat Company, Room 11, Arcade Building, Springfield, Ohio.

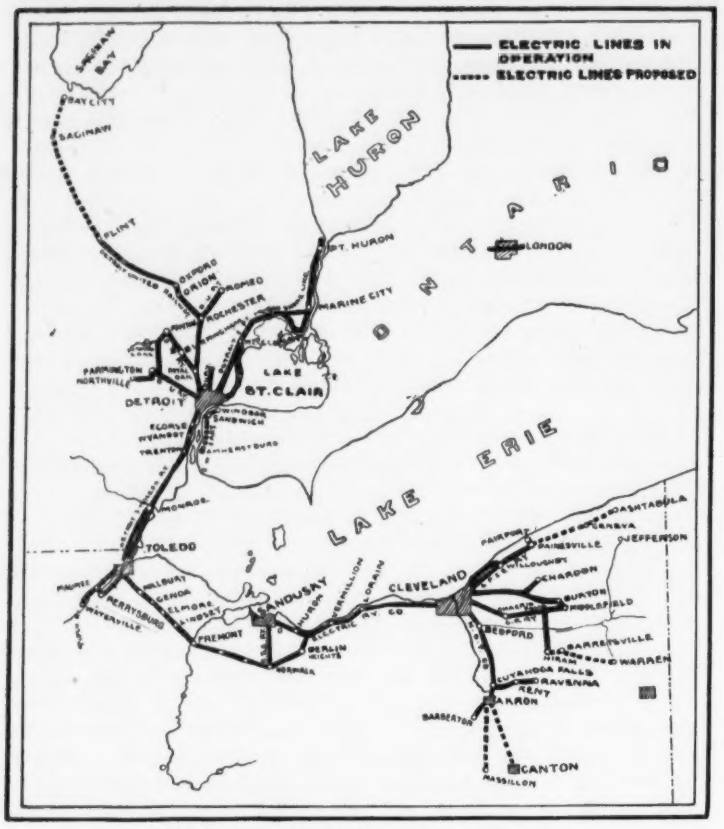
The Everett-Moore Trolley System.

The recent financial embarrassments of the Everett-Moore Syndicate have directed special attention to this organization, which is more or less well known to our readers through frequent references in these columns in the recent past to its development. Latterly the syndicate has become largely interested in independent telephone properties, but its original undertakings were in electric railway work, and this is yet its principal business.

The extensive railway system now controlled by the syndicate is located in the northwestern section of Ohio and the southeastern corner of Michigan, and is known as the Lake Shore Electric Railway, although the various constituent properties have names of their own. The rapid growth of this combination of railways, and the wide scope of its plans, constitute one of the most remarkable features of electric railway enterprise development. Combinations of this character are developing in many sections of the country, but none has attracted more widespread attention than this one has. Enterprises of this nature are usually conducted in the East with more or less conservatism, but in the West they are carried forward with a vigor that is refreshing, if hazardous. This is particularly true of the Everett-Moore Syndicate, which has attained much prominence in the financial and electric railway worlds.

The extent of the Lake Erie Electric Railway's system is shown in the accompanying map. The system embraces the Cleveland Elec-

tric Railway Co., which controls about two-thirds of the Cleveland street railway system; the Cleveland, Painesville & Eastern Railroad Co., which operates a suburban line from Cleveland to Painesville; the Cleveland & Eastern Railway Co., operating a line between Cleveland and Chardon, Burton and Middlefield: the Cleveland & Chagrin Falls Electric Railway, running between Cleveland and Chagrin Falls; the Detroit United Railway, which is a consolidation of the entire street railway system of Detroit, and suburban electric railways from Detroit to Pontiac, Wyandotte, Trenton, Flint, Romeo, Rochester



MAP OF EVERETT-MOORE TROLLEY SYSTEM.

and Orchard Lake; Detroit & Port Huron South Shore Line Railway Company, operating suburban roads between Detroit, Port Huron and Mt. Clemens, also the city lines in Port Huron and Mt. Clemens; the Lorain & Cleveland Railway, a suburban line between Cleveland and Lorain; the Northern Ohio Traction Company, which is a consolidation of all the street railway lines in Akron, suburban lines to Ravenna, Kent, Barberton, Cuyahoga Falls, Bedford and Cleveland, also the electric lighting plants in Akron and Barberton, and the Toledo Railways & Light Company, which includes the entire street railway system and every public lighting plant in the city of Toledo. The companies above-named are integral parts of the system, and all together the roads form a practically continuous line of electric railway from Painesville, on the east, to Toledo and beyond, on the west, and northward through Detroit to Port Huron over one branch and to Flint over another. As shown on the map, extensions from the extreme termini are projected eastward from Painesville to Ashtabula, and westward from Flint to Bay City, Mich.

The following table shows the miles of track of the above-named companies, and is compiled from a circular recently issued by the Everett-Moore Syndicate:

Company.	Miles of Track.
Cleveland Electric Railway Company	136
Cleveland, Painesville & Eastern Railway Company	41
Cleveland & Eastern Railway Company	45
Cleveland & Chagrin Falls Electric Railway Company	15
Detroit United Railway	365
Detroit & Port Huron Shore Line Railway Company	106½
Lorain & Cleveland Railway	24
London (Ont.) Street Railway Company	28
Northern Ohio Traction Company	89
Toledo Railways & Light Company	101
Total	950½

The above table includes the system of London, Ont., which was not included in the first list of roads for the reason that it is not a part of the main system, although it is controlled by the syndicate.

It is now possible to travel continuously from Painesville to Toledo, a distance of about 140 miles, on the electric railways of the Everett-Moore syndicate.

The total capitalization of the component roads of the Lake Shore Electric Railway is $47,000,000. From end to end, nearly 360 miles, it draws from a population of from 4,000,000 to 5,000,000 people.

In a recent banquet of the Toledo Chamber of Commerce, Mr. Albion E. Lang, president of the Toledo Railways & Light Company, gave some interesting facts concerning the interests of the Everett-Moore Syndicate. The effect of the electric railways in Cleveland, he said, was shown in the case of the Hollenden Hotel, which had to build two additional stories because of the growth of patronage due to electric roads. Traveling men now take the cars to the surrounding small towns, transact their business and return to the city for the night. What is true in Cleveland is true elsewhere. He stated further that the company's engineers are now engaged in the preparation of the plans for what will be the largest power house in the world. It will be located in the coal belt of Ohio, and it will utilize refuse coal. Its energy will reach out 100 miles in several directions. Other power houses will then be dismantled, only central plants being retained, one each in Detroit, Toledo and Cleveland. It will be a zone system, the big houses feeding in a measure on the others. Economy in this way means reduced charges on passenger traffic.

Electro-Chemical Patents of the Week.

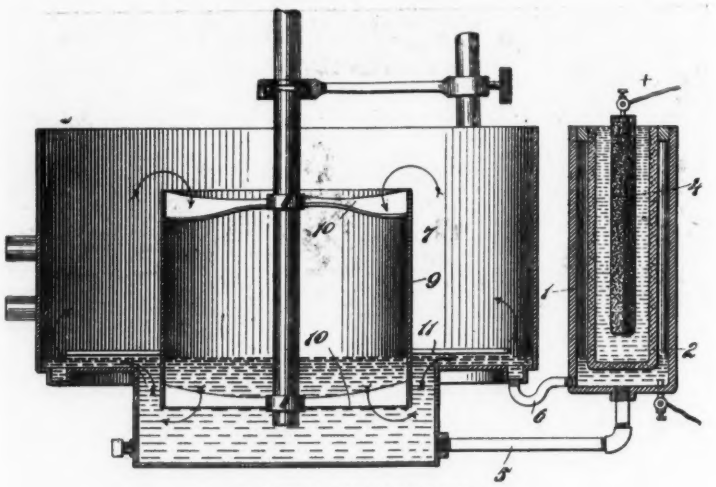
The final patent issue of the year comprises a number of interesting processes and devices relating to widely different branches of the general subject of electro-chemistry.

CALCIUM CARBIDE.

Isaiah L. Roberts, of Brooklyn, proposes to form this compound by supporting a body of commingled lime and carbon in the angle between two plate electrodes, pivotally supported at their upper ends, and brought into arcing distance below by adjusting screws. The claims are restricted to a mode of manipulating the current whereby the carbide is fused as formed and caused to drop away from the electrodes. The application upon which this patent issued was filed early in 1896, before the lack of economy and loss of efficiency by complete fusion of the carbide were fully established.

TREATMENT OF ORES.

Edward Leslie Graham, of Upper Warlingham, England, suggests a method of electrolytically comminuting ores preparatory to mechanical concentration by known means—a method which seems to depend



ELECTRIC AMALGAMATOR.

largely on the mechanical effect of the gases liberated at the electrodes. The solution used is dilute sulphuric acid, to which hydrofluoric acid or fluor-spar may be added. The ores are immersed in the liquid and the current transmitted. A method practically identical with this save as regards the specific electrolyte employed has been heretofore patented in England. While it is conceivable that the liberated gases and the heat developed by a heavy current might rapidly break down certain ores, and that the presence of hydrofluoric acid might aid the process as applied to a siliceous gangue, it is evident that the method is by no means of general applicability.

An electric amalgamator patented to Vicente Pazos y Sacio, of Peru, is in essential respects the device patented in England nearly 20

years ago by Donkin, a device which was the precursor of the Castner alkali cell. Referring to the accompanying illustration, an electrolytic cell 1, containing an anode 4 and diaphragm 2, communicates through pipes 5, 6, with the amalgamating vat 7, mounted centrally within which is the agitator 9, 10, 11, with helical blades disposed to effect a circulation of the ore in the direction indicated by the arrows. A body of mercury fills the lower reduced portion of the vat and the bottom of the electrolytic cell, and is kept in circulation between the two by the movement of the blades 10. In operation the vat 7 is filled, above the mercury, with ore pulp and dilute cyanide solution, and the porous cup 2 with a solution of sodium chloride. Under the action of the current sodium amalgam is formed in the smaller cell and at once transferred to contact with the ore, where it serves to amalgamate such free gold as may be present, and to reduce from its solution the metal which has been dissolved in the cyanide.

SOLUTION OF NATURAL PHOSPHATES.

The natural phosphates, as the mineral apatite, the coprolites, and the phosphate rocks, consist largely of the tri-basic phosphate of calcium, the immediate plant-food value of which is slight. By treatment by acids or acid salts this tri-basic salt passes into the mono and dibasic compounds, the former soluble in water, and the latter, to some extent at least, in the soil moisture. Lewis Cheeseman, of Alexandria, Va., proposes to accelerate this conversion by the use of a strong electric current. The solvent used is acid sodium sulphate (nitre-cake), and there seems to be no doubt that the current very materially increases its solvent effect, probably owing to the concentration of the SO_4 ions in the neighborhood of the anode. The effect would probably be even more strongly marked were the phosphate confined to the anode compartment of the cell.

CHLORINE AND ALKALI.

Wilhelm Gintl, of Aussegg, Bohemia, patents an interesting modification of the well-known Richardson-Holland electrolytic cell. The anodes are contained in inverted bells, which the cathodes surround. No diaphragm is used, but for preventing intermingling of the caustic and chlorinated solutions dependance is placed upon their widely differing specific gravities. It is clear that to maintain a stratification of this character, the electrolyte must be fed in with absolute uniformity, and this is the object of the improvement now patented. It is accomplished by using an anode of such size and shape as nearly to fill the inverted bell, and feeding the electrolyte by means of a distributor over its upper submerged surface. The fresh electrolyte, in passing downward through the narrow spaces around the anode and through perforations in the latter, meets the rising chlorine bubbles, and is thereby thoroughly commingled, yet with the minimum of agitation, with the exhausted liquor, maintaining the necessary uniformity of its composition. Recent measurements have indicated a surprisingly high efficiency for cells of this character, and it is not beyond the range of probability that this or a similar cell may successfully enter the commercial field.

New Telephone Patents.

To the last issue of the Patent Office of the year just closed telephony contributes four patents, all of them of substantial interest to the art of telephony, party line systems, freak receivers and telephonic relays for once being entirely absent. Mr. Francis W. Dunbar, of Chicago, patents and assigns to the Kellogg Switchboard & Supply Company a switchboard system in which the principal feature is a relay for switching the line from the line signal to the answering jack, and which is an improvement on his previous system of the same order. This invention also provides an improved form of test for multiple switchboard systems, the additional contact usually provided on the spring jack for testing purposes being dispensed with, and one of the line contacts being used for the test terminal.

When the line is not in use, the line contact of the spring jack is disconnected from the portions of the limbs of the line extending to the sub-station, and is also disconnected from the individual indicator and the central station circuits. The line contact of the spring jack is thus free from all extraneous currents or sources of electricity that might impart a difference of potential when not in use. Accordingly, no false test can be given, and the line contact may be used as a test terminal.

In the diagram Fig. 1 shows two subscribers' lines and the central

Fig. 1

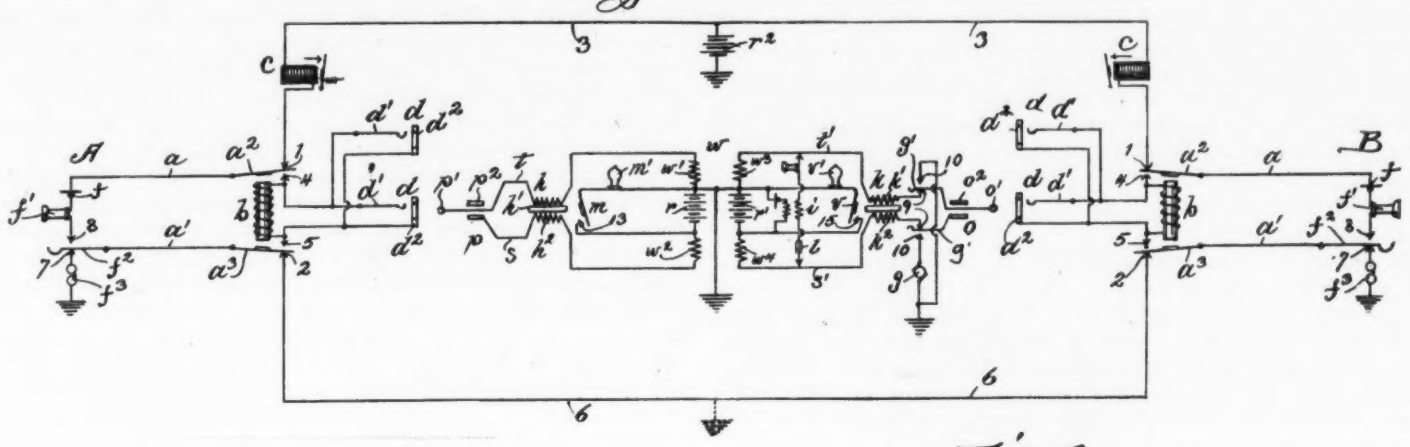


Fig. 2.

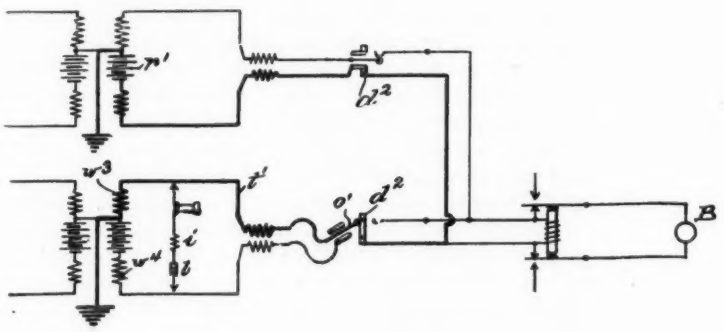


Fig. 3.

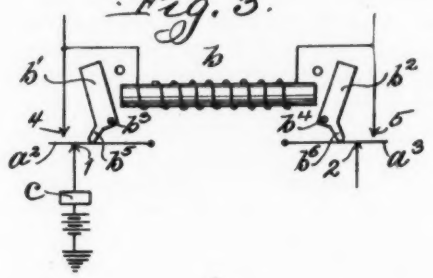


Fig. 4.

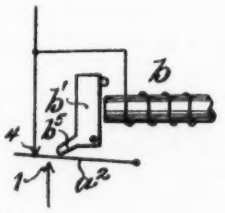


DIAGRAM OF CIRCUITS OF THE DUNBAR TELEPHONE SWITCHBOARD.

office connecting circuits. Fig. 2 shows the test circuit. Fig. 3 shows the relay preferably employed, and Fig. 4 illustrates one end of the relay with the armature attracted.

Referring to Fig. 1 the sub-station lines normally connect with the line signal and ground by reason of the springs a^2 a^3, in which the lines terminate, being normally in contact with 1 and 2, and so connected through line signal c through battery r^2 to ground on the one side, and to the common ground by wire 6 on the other. The two wires, s^1 and t^1, of the calling plug o, are connected to a repeating coil w, having two coils, w^3 and w^4, between which is inserted a battery r^1. The calling plug in the same way is connected to windings w^1 w^2, with battery r. One pole of each battery is connected to ground. In the cord strands t and s are included, the windings h^1 h^2 of a relay h, and in the strands t^1 and s^1, the windings k^1 and k^2 of relay k are included. When the battery current for talking traverses the coils of these relays they neutralize each other and are inert; when a circuit is made from the ground through battery r^1 along strand s^1, coil k^2, sleeve o^2 and line a^1 to ground at the sub-station (by the replacement of the receiver on the hook), the relay is energized and the disconnection signal r^1 is displayed.

The relay b is constructed so that it will respond to alternating as well as to continuous currents, the armatures being mounted so that they are withdrawn from the relay poles by gravity. The withdrawal of the armatures is thus sluggish, and upon the passage of an alternating current a succeeding alternation will magnetize the core and cause it to grasp the armature before it has had time to be withdrawn. As shown in Fig. 3 the armatures b^1 b^2 are pivoted at b^3 b^4, respectively, so that the weight of the armatures serves to withdraw them from the core. The armatures are provided with arms b^5 b^6, adapted to engage springs a^2 a^3. When the relay is inert b^5 holds a^2 in engagement with contact 1, and b^6 holds a^3 in engagement with contact 2. When the armatures are attracted b^5 and b^6 allow a^2 and a^3 to engage contacts 4 and 5.

When a subscriber, say, A, lifts his receiver from the hook line signal c is energized by battery r^2. When the operator plugs in relay b is energized by battery r and the line is switched from the line signal contacts to the jack contacts by the closing of a^2 a^3 on 4 and 5. The same occurs with the second line on the insertion of the calling plug o in the jack of the second line. During conversation the battery r supplies subscriber A and the battery r^1 subscriber B, talking currents being transmitted by the windings of repeating coil w. When the operator rings B the battery r^1 is cut off by the ringing key, but relay b is in bridge with the generator, and being responsive to alternating currents maintains the line in connection with the jack. In testing for "busy" the operator touches the tip of plug o to the rim of the jack in the usual way; if the line is idle the jack is totally disconnected, and there can be no signal. If the line is engaged, as shown in Fig. 2, the line springs of all the jacks are charged to a difference of potential relative to the ground. When the operator touches plug-tip o^1 to jack-sleeve d^2 the current from battery r^1 finds a path through o^1, strand t^1 and winding w^3 of repeating coil to ground. The closing and opening of the circuit caused by touching the tip o^1 to the sleeve and the removal of the same therefrom causes a current of self-induction from winding w^3 to traverse the local circuit, including the windings w^2 and w^4, and the receiver of the operator's telephone, and the induced currents thus produce the click in the operator's receiver which indicates to her that the line is busy.

Mr. James L. McQuarrie, of Chicago, patents and assigns to the Western Electric Company an improved test circuit for multiple switchboards. This is designed to prevent the production of a false busy test, which, under certain conditions, may occur in the common battery system through current from the central source returning through the circuit of the calling line and changing the electrical condition of the testing plug. In such an event the operator would be supplying from within, as it were, what she ought only to get from without, and would herself be causing a line, which might be free, to test busy—a very annoying defect, and one most detrimental to good service. Mr. McQuarrie applies a remedy by so arranging listening key and repeating coil that the tip conductors of the two plugs are not continuous while the test is being made, consequently no false test can occur through one plug supplying the other with current.

An interesting development of the use of ten-party lines is the invention of a time-regulated ringing key for mechanically sending signals over party lines where the call for each station is distinguished by the number of rings given. Since the use of these ten-party lines has been more largely developed in California than in any other part of the country, this invention most appropriately hails from San Francisco, and is due to the ingenuity of Mr. Frank W. Alston. As might be expected, it is a fairly complicated device, and one, since it would be so constantly in use, that would have to be very strongly made to give the required performance without frequently getting out of order. It is difficult to do justice to such a complicated piece of mechanism in an abstract, but briefly put, the time-regulated ringing key consists of a plunging key, a selector which is set to give the required number of signals, and which releases the depressed key when the determined number of signals has been given, and a contact sector with a clockwork-driven contact brush that connects the generator to the connecting cord at fixed intervals as long as the plunger is depressed.

In using the key the operator turns the plunger until the pointer shows that the selector has been set to allow of the proper number of rings being given and then depresses the key. If, say, 3 rings are required the selector pointer is set at 3, and this causes the plunger to be released when three rings have been given by the contact brush coming in contact with a segment that has been connected by the selector for the purpose of energizing the releasing magnet.

An ingeniously worked out telephone meter is patented by Mr. Henry A. Holdrege, of Chicago. One difficulty with a meter automatically operated by the action of inserting the answering plug in the answering jack is that the call so registered is so far merely a call and not a message. The call may never become a completed message because the second subscriber may be busy or may not answer. This occurs sufficiently often to render a meter operated by the answering plug practically useless. Mr. Holdrege's meter operates only when the connection is completed, the last step in the registration taking place when the connection is broken.

The meter does not begin to register until the called subscriber takes down his receiver and does not complete the operation until the connection is taken down. Moreover, the meter will register a unit only without regard to the duration of the connection. The meter will not meet all points that arise in telephone traffic, but in postponing registration until the two stations are in communication, Mr. Holdrege's has scored a distinct point. Whether the unbalanced circuit that results from the insertion of a relay in one leg of the line will offer serious inconvenience is a question that experience will answer.

General Greely on Wireless Telegraph Matters.

With regard to the adoption of wireless telegraphy by the United States Government services, General Greely says: "The system has its limitations, which are not entirely dependent on distance. For example, we wanted to lay a cable between a point on the Connecticut coast and Gardiners Island. I was asked by the members of the appropriations committee whether it would not be cheaper to establish a wireless system between these two points. I showed that as far as simply establishing that plant was concerned it would be cheaper to put up the wireless systems than to lay the cable, but when it came to operating the systems, I showed that the cable was the cheaper of the two. In wireless telegraphy you have to have two experienced electricians, one at each station, and they must have assistants. With the cable you can put in two long-distance telephones, and anybody can use them who is able to turn the magneto crank. While it costs more to lay the cable, yet in this case we found that it would be cheaper in the end than the wireless system."

General Greely has received recently a very interesting report from Signal Corps Sergeant F. E. Peters at San Francisco as follows, on the plant in the harbor there:

"The stations in operation in this harbor have been working uniformly and satisfactorily each day, thus proving that so far as the transmission of messages is concerned, the system is an absolute success. It lacks speed as compared with wire lines and is only capable of dispatching accurately 15 words per minute. There seems to be no limit in sending, but the speed is lost in the receiving instrument. There are many conditions under which it could be used, but in nearly every case it would merely intrude upon a field which could be easily covered by telephone or telegraph lines. The following defects have come under my notice: First, the apparatus needs condensing and simplifying; second, a lack of speed, compared with land lines; third, the inability of an operator to break or interrupt another; fourth, the lack of secrecy in regard to matter being handled; fifth, the impossibility of operating more than one set of instruments in

an office; sixth, the impossibility of operating more than one system within the limits of its range.

"The first three defects seem entirely within our ability to overcome. The fourth is that we cannot prevent our system from being tapped, except by the adoption of a secret code. The fifth and sixth objections, as far as I can see, must remain with us unless our knowledge of syntonizing arrangements be advanced materially."

Automatically Closing Bulkhead Doors.

By invitation of President Schwab, of the North German Lloyd Steamship Company, a party was entertained on board the steamship "Kronprinz Wilhelm" on Friday, Jan. 3. The occasion was the first public exhibition of the Dörr system of safety doors in bulkheads of steamships, and after a thorough inspection of the apparatus the guests were entertained at luncheon. For a number of years, the steamship line has been investigating devices which would insure the greatest amount of safety to its vessels in case of collision, and after a number of most extensive and costly experiments it has introduced the present system on a few of its boats, and intends placing it on all of the rest. The doors slide in vertical ways, and are closed automatically by hydraulic pressure from an operating wheel on the bridge behind the pilot house, and the system is applied to the 19 or 20 bulkhead doors below the water line. In order to operate the wheel on the bridge, a trip lever has to be elevated out of the way, and by an ingenious ratchet arrangement, it requires some 20 seconds before the wheel is free to turn. While the lever is being moved electric bells are sounded at every door, giving warning for about 20 seconds before the doors begin to close slowly from the action of the hydraulic cylinder. The doors can be closed by hand, independently of the hydraulic apparatus, and a lever is provided at each door by which it can be made to drop into its closed position almost instantly. An ingenious system of electric signals has been adopted in connection with the doors all over the ship. In the pilot house is a large diagram, showing all the decks, and at each point where there is a bulkhead door a small bull's-eye is placed. Behind these bull's-eyes are signal lamps connected to switches at the doors in such a manner that whenever a door is closed the lamp is lighted. In this way the officer on watch has the position of the bulkhead doors throughout the entire ship directly under his eye. A complete fire-alarm system is also included in the equipment of the "Kronprinz Wilhelm," with stations located in all parts of the steamer. The signal boxes are similar to those found on land, a glass pane having to be broken to set the alarm in action. An annunciator in the pilot house shows the location from which the alarm is sent in.

Mr. Carnegie's National Institute.

Some details have already been given in these pages as to the plans of Mr. Andrew Carnegie for founding a new educational institution at Washington. In accordance with the desires of Mr. Carnegie, a corporation known as the Carnegie Institution has been formed in Washington for the purpose of holding in trust the $10,000,000 which he will give to found a national university. The certificate of incorporation, filed with the Recorder of Deeds, is signed by John Hay, Secretary of State; Edwin D. White, Justice of the United States Supreme Court; Daniel C. Gilman, former president of Johns Hopkins University; Charles D. Walcott, superintendent of the United States Geological Survey; John S. Billings, former Surgeon General of the United States Navy, and Carroll D. Wright, Commissioner of Labor.

The certificate placed on record sets forth that the incorporators desire to establish in the city of Washington an institution for prosecuting original research in science, literature and art. The corporation is empowered to acquire, hold and convey real estate and other property, and to establish general and specific funds; to conduct, endow and assist investigation in any department of science, literature or art, and to this end to co-operate with governments, universities, colleges, technical schools, learned societies and individuals; to appoint commissions of experts to direct special lines of research; to publish and distribute documents, to conduct lectures, to hold meetings and to acquire and maintain a library.

The significance of the incorporation is that the government is relieved from becoming trustee of the Carnegie fund, whether it takes the form of steel bonds or United States securities.

The Grounding of High Potential Circuits.

At the joint meeting the Chicago Electrical Association and the American Institute of Electrical Engineers held at Chicago Jan. 3, John D. Nies, instructor in electrical engineering at Lewis Institute, presented a short paper on the "Grounding of High-Voltage Circuits." The paper was a mathematical discussion of the practice of grounding the neutral point of a three-phase transmission line when the transformers are connected Y fashion. The paper was suggested by calculations recently made by Mr. Nies to determine whether the practice of grounding the neutral point of certain transmission lines introduced any greater element of danger to insulation or to persons. The conclusions reached in the paper were that in the majority of ordinary conditions where there is capacity in the lines to any appreciable amount, the grounding of the neutral point is a practice which affords less danger from leaks to earth and from shocks than the practice of leaving the neutral not grounded. Each case must, of course, be calculated, but in the great majority of cases which come up in practice the condenser capacity of the transmission lines is sufficient so that the danger from shocks and tendency to leak from one wire to the ground is greater with a non-grounded neutral. This is, of course, due to the capacity of the lines. Mr. Nies considered first a single-phase circuit with the middle point of the transformer grounded, and then a three-phase circuit with the Y connection of transformers. The relation between any two wires and ground is that of two condensers in series, the line wires forming two plates of the condenser and the ground the third plate. Mr. Nies' calculations on a number of cases showed that the current flowing through a person or other leak to ground would be greater and the effective voltage would be greater with the neutral point not grounded.

CURRENT NEWS AND NOTES.

TRANS-ALPINE TELEPHONE LINE.—The telephone systems of France and Italy are now connected by means of a trans-alpine telephone line, which was inaugurated on Jan. 1. Signor Galimberti, Italian Minister of Posts and Telegraphs, exchanged greetings from Turin with President Loubet at Paris.

PARIS METROPOLITAN.—A cable dispatch from Paris of Jan. 4 says: The extension of the Metropolitan Underground Electric Road has encountered unexpected difficulties. A new section from the Etoile to the Place du Trone, passes under the catacombs. The line will have to be carried much lower down before a firm roofing can be safely built. Its completion will probably be retarded for an indefinite time.

TRAIN LIGHTS.—A telegram from Chicago of Jan. 4 says: Train dispatchers of the country want all possibility of collisions removed by doing away with the present system of train orders that can be misinterpreted and signals that may be unseen. Instead of these methods it is proposed to substitute colored electric lights in the engine cab, signals that always can be seen and never can be misunderstood. This system of movable blocks or lights in engine cabs is being installed on the Chicago & Eastern Illinois Railroad. The experiment will be watched with interest by railroad men throughout the country.

ELECTRIC RAILWAYS IN OHIO.—J. C. Morris, State Railroad Commissioner, has filed with Governor Nash a complete report of the status of railroads in Ohio for the year ending Nov. 15. A portion of the report was devoted to electric railways. Mr. Morris states that the history of electric railways in Ohio began with the incorporation on July 30, 1889, of the Soldiers' Home Electric Railway, operating from Dayton to the National Soldiers' Home, near that city. During the year ending Nov. 15, 1901, 96 electric railway companies were incorporated, with total capital stock of $24,361,000. On May 1 there were 63 operating companies in the state with 1,818.16 miles of line, an amount equal to one-fifth of the total steam mileage of the State. For 1900 the Ohio roads reported to the State Auditor total gross earnings of $11,301,172, while for 1901 the figures were $13,582,851, a gain of 20.18 per cent.

WIRELESS TELEGRAPHY FOR TIMBUCTOO.—The French Government proposes to connect Algiers and Timbuctoo by wireless telegraphy.

DR. F. A. C. PERRINE will lecture before the New York Electrical Society, at the College of the City of New York, on Jan. 15, his subject being water power conditions and electric power transmission on the Pacific Coast. Dr. Perrine is an authority in this field, and has lately returned from a personal investigation of work in the Far West. His lecture will be freely illustrated with lantern slides, and will doubtless be one of the best of the season.

CONDITIONS OF RAILWAY TRAVEL.—As a result of the withdrawal of exchange passes by Eastern lines, traveling passenger agents on Western roads in New England are to use every effort to travel as little as possible over the railways and use the trolley lines whenever it is possible, in preference to the railroads. At a meeting in Chicago last week between General Manager Delano and the principal passenger officials of the Burlington system in the East, they were instructed to reduce traveling expenses to a minimum and to use the mails, telephones and telegraph whenever possible, if business can be secured, instead of paying railway fares from point to point.

IRELAND-AZORES CABLE.—Consul Thackara reports from Havre, Dec. 5, 1901, that the Commercial Cable Company, of New York, has laid a new submarine cable between Horta, Island of Fayal, Azores, and Waterville, Ireland. The shore connections at the latter place were successfully made on Nov. 30. This cable, says the consul, is an extension of that laid by the same company in 1900, and increases to four the number of cables operated by the Commercial Company between Canso and Waterville. As Havre is connected by a submarine cable with Waterville, the direct-telegraph service with New York will be benefited by the new cable. Note of this cable has already been made in our pages.

FRENCH AUTOMOBILISM.—It is stated from Paris that Mlle. Chossegros, who left $400,000 to the Société Protectrice des Animaux, made provision for the creation of an automobile van for removing injured horses from the street. The society has opened a competition among automobile constructors for the new ambulance, which is to cost $4,000, Baron de Zuylen having the project in charge. The Automobile Club has inaugurated an auxiliary membership, constituting a kind of annex for modest chauffeurs whose wealth and station are not important enough to secure regular membership. The new members pay $4 a year, and will have a room reserved for their use in which lectures and technical conferences will be held.

MARCONI IN CANADA.—Mr. Marconi has been at Ottawa, Canada, during the present week in conference with the officials of the Dominion Department of Marine. The negotiations appear to deal with the utilization for wireless telegraphy of Sable Island, known as the "graveyard of the Atlantic," on account of the number of wrecks that have occurred there. A dispatch from Ottawa of Jan. 5 says: "It need surprise nobody if, as a result of Signor Marconi's visit to the Department of Marine, Sable Island, the scene of so many shipwrecks, is chosen as a Government station for transmitting warning signals to the throng of steamers that continually cross and recross the Atlantic within a comparatively short distance of its treacherous shores."

ELEVATED RAILWAY IN PHILADELPHIA.—In a dispatch from Philadelphia the announcement is made that work will soon begin on the construction of an elevated railway on Market Street, in that city, from the Delaware River to Sixty-third Street. It is expected to have the road in operation by the first of January next, if there is no delay in the delivery of structural steel. The road is to be of the modern construction, and will be operated on the third-rail system. It is further stated that elevated roads will be ultimately constructed on Woodlawn Avenue, Broad Street and other thoroughfares. It is the intention to connect the stations of the Philadelphia & Reading and the Pennsylvania Railway companies with the Market Street elevated. It is intimated that Mr. J. Pierpont Morgan is interested in the enterprise, and that he is financing the scheme.

DINNER TO MR. MARCONI.—Learning that Mr. G. Marconi would pass through this city on his way to England within the next few days, the American Institute of Electrical Engineers, with commendable energy and judgment, telegraphed to Canada, inviting him to be the Institute's guest at the annual dinner which usually takes place this month. Mr. Marconi has accepted this honor in a cordial response from Ottawa, where he has been in consultation with the Government. He arrives in New York Saturday to sail for England on Wednesday, and the dinner committee have, therefore, chosen Monday, Jan. 13, at 7 P. M., in the Astor Gallery of the Waldorf Astoria. The price of tickets, which can now be obtained from Secretary Pope, is $4, without wine, and in response to the very general inquiry and request, ladies will also attend and participate. A large gathering is indicated for this most interesting occasion, and it is expected that President Steinmetz will preside. Among the speakers will be Professor Elihu Thomson, Dr. M. I. Pupin and other well-known gentlemen.

LETTERS TO THE EDITORS.

Theory of the Edison Nickel-Iron Cell.

To the Editors of Electrical World and Engineer:

Sirs.—I regret that other important work has precluded my doing the requisite experimental work to reply before this date to the article of Dr. Roeber in your issue of Dec. 7, in which Dr. Roeber criticises my brief discussion of the electro-chemical theory of the nickel-superoxide-caustic potash-spongy-iron accumulator, commonly called the Edison storage battery. I read the article with interest and surprise, for I failed to comprehend how any one with such a knowledge of physical chemistry as Dr. Roeber shows he possesses in his able analysis of reversible electrodes should have misquoted and misunderstood any person in the manner that he has misquoted and misunderstood me.

I said in my article that p_1 and p_2 represent the "aqueous tension" of the solutions. Dr. Roeber says that "what is meant by 'aqueous tension' is not clear, but he evidently means osmotic pressure." Aqueous tension of a solution can only mean one thing, the "vapor-pressure" of the water, causing it to leave the solution in the gaseous form, with a resultant concentration of the solution. Any chemist can understand this and only this in the phrase "aqueous tension." (Dampfspannung.)

It is quite different from osmotic pressure ("Osmotischer druck"). This latter registers the tendency of the solute to leave the solution in the form of solid, or liquid, or gas, with a resultant diminution of the solution. Osmotic pressure and aqueous tension are, it is true, both pressures and both usually measured in millimeters of quicksilver, but they are opposite in action and as different as the poles of a magnet.

The formula for the difference of the e. m. f. of two cells of the type $M \mid M O_x \mid K O H \mid H_2 \mid P T$ is derived as follows:

The chemical reaction is $\frac{H_2}{P_h} + M + \frac{M O}{P_0} + K O H = 2 M + \frac{H_2 O}{P} +$ $K O H$, where p_0 is the very small oxygen dissociation pressure of the oxide in millimeters Hg; p_h the pressure of H_2, usually 760 millimeters; Hg, p the aqueous tension of the solution measured in millimetres of Hg. Accordingly p_0 and p_h are independent of the concentration of the $K O H$, as can be seen readily.

On passing 96,540 coulombs of electricity through two of these cells of different concentration connected positive to positive, the net change that takes place is the formation of 9 grams of water in the concentrated cell, and the disappearance of 9 grams in the cell with dilute electrolyte. The combination of the metal with the oxygen in the first cell and the dissociation of the oxide in the second cell as they take place at nearly the same pressures, balance each other and cannot evolve any electrical energy.

We have merely transferred water from one pressure p_1 to water at another pressure p_2, assuming that the cells are so large that the concentrations of their electrolytes are not affected materially by the change. As the cell is reversible, the energy given out in external work, in overcoming the electrical resistance of the circuit (in other words, the free energy or potential of the system), is equal to the work which would be done in distilling at constant temperature 9 grams of water from p_1 to p_2.

Expressing the above mathematically in the proper units we have

$$\varepsilon_1 - \varepsilon_2 = 0.029 \log \frac{p_1}{p_2} \text{ volts.}$$

The above formula I have tested experimentally in the cases of cuprous oxide, cupric oxide, electrolytic cobalt peroxide and electrolytic nickel peroxide. As the theoretical differences are in the millivolts, the limits of experimental error are such that the verification was not as close as could be desired.

The e. m. f. of cells of the type *M/K O H/M Ox*, or "oxygen lifts," are also nearly independent of the concentration. The free energy of the process is the same because the solvent plays no part in the reaction. As was remarked in the previous article, the lead accumulator requires a different formula because both the electrodes react with the solvent. The free energy of the reaction $Pb + PbO_2 + 2H_2SO_4 = 2PbSO_4 + 2H_2O$, varies greatly with the concentration of the electrolyte, consequently the voltage varies considerably with the concentration of the electrolyte. This is brought out clearly in Dr. Dolezalek's book, "Die Theorie des Bleiaccumulators," p. 34 *et seq.*

WOOLSEY MCA. JOHNSON.

HARTFORD, CONN.

Safety of Consumers and Grounding of Secondaries.

To the Editors of Electrical World and Engineer:

Sirs.—It appears to me that the attention of the electric lighting interests of this country should again be called to the recurrence at various intervals of serious accidents to electric light consumers in the way of shocks received from supposedly harmless low-tension incandescent lighting circuits run as secondaries from transformers fed by high-tension alternating current. These shocks are due, of course, to leaks from the primary to the secondary coils of a transformer or to crosses of high and low-tension overhead wires. There is undoubtedly considerable negligence in this respect in many quarters, when it is considered how easy it is to make low tension secondary circuits and lamp sockets connected thereto perfectly harmless to the lives of those handling them. The precaution of grounding the secondary circuits at some point or putting in some equivalent automatic device makes it impossible to have a dangerous potential between any part of the circuit and ground. This is an absolute safeguard against loss of life from contact with such low-tension circuits.

The practice heretofore in this country has generally been not to ground the secondaries. This was formerly due partly to a harmful conservatism on the part of the underwriters, but mainly to the theory inherited from the early days of alternating-current distribution that transformer primaries and secondaries never become crossed and that hence there could be no danger. Every one who operates an alternating-current lighting plant knows how far it is from true that transformers never become defective so that there is a leak between coils. While it is true that this is not of frequent occurence that very fact makes it the more dangerous when it does occur, because it is unlooked for. Furthermore, the general public has a right to expect and does expect that all wires within reach will be absolutely harmless at all times. Safe they cannot be with a leak between primary and secondary transformer coils unless the secondary is grounded, because there is always sufficient leak between the primary distribution system and ground to make it uncomfortable for any one who puts himself between primary and ground. That more accidents do not occur from the numerous defective transformers that are taken down every year is due simply to the fact that no one happens to make a sufficiently low resistance path with his body between secondary and ground in the majority of cases. In the remaining minority of cases there is a call either for a doctor or a coroner, depending on the ohmic resistance of the path.

While the decision of the courts in damage suits resulting from such cases may not entirely agree up to date, owing to a misty understanding of technical matters in the judicial mind, it is manifest that in the end electric lighting companies will be held liable for damages from shocks received in this way in all cases, and the electric lighting companies of the country will be wise to take cognizance of the possible dangers and apply the remedy.

That there are some small objections to grounding the secondaries does not justify not doing so when it is a case of protection of human life, especially when it is considered how frequently transformers have insulation punctured during lightning storms without any one's knowledge. One argument against grounding secondaries is that in case the transformer becomes defective the fuses will blow and cut off the service. When a transformer is leaky it is high time that the service be cut off before some one is hurt, and the only practical way to find out the dangerous condition immediately upon its occurrence is to ground the secondary. Again it is argued that with the secondaries grounded the insulation in the transformer is put under greater strain. The answer to this is that when the primary insulation is so weak to ground that it needs the help of the secondary insulation to help it out it is so near a point of breakdown that the small increased life gained by the absence of a ground on the secondary is not worth the risk. Whatever objections may be urged, it can be taken for granted that they received due consideration from the committee of the American Institute of Electrical Engineers charged with the investigation of the subject, the report of which committee favoring grounding was adopted by the Institute, and, we believe, indorsed by the Underwriters' Association.

CHICAGO, ILL. CHAS. T. DASHIELL.

Conditions of Money Order Telephony.

To the Editors of Electrical World and Engineer:

Sirs.—I have read with much interest the opinions presented in your issues of Dec. 7 and 14 in regard to the telephone money order system. The great difficulty in such a system seems to be the proper identification of the persons sending the order, to insure the company against loss.

What I want to suggest is a little instrument that we might call an "identifier," that would identify the party sending the order beyond any doubt. By the use of this little instrument we obviate all, or nearly all, of the difficulties connected with sending money by telephone, especially those difficulties pointed out in your editorial of Dec. 14. It would not be necessary to have a special money order wire, as some suggested, nor would the publicity of the telephone be any disadvantage whatever, as only the proper parties could be identified.

This little instrument could very easily be made to give forth sounds into the transmitter of the sending telephone, that could be instantly recognized, but would be impossible to imitate without the little instrument itself. The sound-producing part of the instrument would best be made on the principle of the phonograph, or some other form of the talking machine, i. e., a record and a reproducing mechanism or diaphragm. The sound-producing part or record should be made interchangeable, similar to the interchangeable record of the phonograph. It could be made to reproduce any combination of words, sentences, musical notes or any imaginable combination of sounds. As the record need contain only a few words or sounds, the whole machine could be made very small and compact. It could be made as a part of the telephone instrument or could be made very compact and portable to be carried in the pocket.

The principal parts of the "identifier" are: An interchangeable record; a speaking diaphragm; a spring motor or some driving mechanism to insure uniform speed; a case or box to contain the mechanism, provided with a key or combination locking device.

I believe an instrument as above described would have a much wider field of usefulness than just in the transmission of money. It could be used in a great variety of business transactions over the telephone, giving, as it would, a stamp of genuineness to the communication.

It would be a very easy matter to establish a reliable system of stations where money could be paid and transmitted by telephone. It certainly would be of immense value to the public, as well as increase the income of telephone companies to no small extent.

I see clearly how an instrument of this kind could be made. I am a student in electricity, but have not the means to develop the idea. I would be very glad to correspond with any one who may be willing to aid me in perfecting this little instrument. I believe that an instrument of this kind will have a great future.

DAVID J. MONOSMITH.

SPENCER, OHIO.

A 19,000-Volt Shock.

To the Editors of Electrical World and Engineer:

Sirs.—In your issue of Dec. 28, 1901, I notice a communication from M. Henri Pieper regarding the survival of a man after receiving a 10,000-volt shock. In this connection I would call attention to

the circumstance related on page 1114 of your issue of June 29, 1901, which, for the benefit of those who have not the article at hand, I will briefly relate here. The Santa Ana-Los Angeles transmission line, owned now by the Edison Electric Company, of Los Angeles, is 83 miles in length, and is operated at about 33,000 volts. The transformers are connected Y fashion, with the neutral point or center connection grounded at both ends of the transmission. This gives approximately 19,000 volts between each wire of the circuit and ground. It is related that a workman one day while climbing up over a transformer case got near enough to one of the high-tension lines so that an arc struck between his skull and the wire. He was picked up for dead, with a hole burned in his skull and the skin burned off the soles of his feet. Fortunately, a gentleman was at hand who was expert in effecting revival from shocks. He rescuscitated the man so that with proper medical attendance and the grafting on of skin to replace that lost he ultimately recovered.

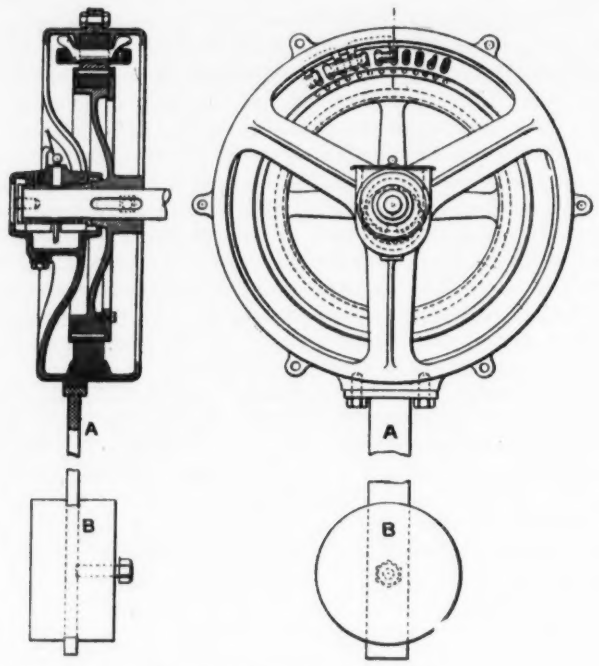
Of course, in none of these cases reported where a human being has inserted himself accidentally in some part of a very high-voltage circuit has he received as large a volume of current as would flow if he were placed directly between the conductors, as no man could do that and live. These acidents simply go to show that it is sometimes possible to get mixed up with such circuits and receive shocks from them in such a way as not to receive the full potential.

CHICAGO. J. R. CRAVATH.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Small Three-Phase Motors.—The three-phase induction motors of small capacity and with a short circuited armature, have generally too great an angular speed for most applications, and also a small starting torque. These disadvantages are claimed to be avoided in motors made by Prinetti and Stucchi, of Milan. To reduce the angular velocity to 100 or 200 r. p. m., they use a large number of poles of the inductor. To obtain a sufficient starting torque, the inductor is not fixed on the ground, but is mounted on the armature axle, around which it can turn, but a long pendulum *A B*, ending in a heavy disk, keeps it in a vertical position, when the motor is at rest, as shown in the adjoining figure. When the motor is started, the pendulum is



SMALL THREE-PHASE MOTORS.

deviated in the direction of the rotation of the armature. The angle of deviation enables one to find the power given out by the motor; it is equal to the product of angular velocity, the weight of the pendulum, its theoretical length, and the sine of the angle which the pendulum makes with the vertical direction. As the power of the motor is thus always evident, overloads are at once apparent; and the arrangement may be made that for a certain overload the circuit is automatically broken by the pendulum. The motors are especially adapted to drive spinning and weaving looms. (A similar device was suggested by the compiler years ago, the only difference being that a coil spring was used instead of the weighted pendulum. This has the additional advantage that the inductor can then make a number of revolutions instead of less than half a revolution, as in the above. It was also suggested to use it in order to facilitate bringing synchronous motors into synchronism and diminishing the risk of their pulling out of step.)—*L'Ind. Elec.*, Nov. 25.

POWER.

Transmission Plant in Agricultural District.—APT.—An illustrated description of the electric power transmission plant at Crottorf, Germany. The plant is in the center of a very fertile agricultural district. The water power of the Bode River is utilized to the extent of 500 hp; the balance of the power is generated by steam engines, coal mines being in the neighborhood. There are two 500-kilovolt-ampere, three-phase generators, the one driven by a steam engine, the other by steam and water power together. At low load the water power alone is sufficient. The voltage given by the machines and used for transmission is 7000. The area over which the power is transmitted, and in the center of which the generating station is situated, has a diameter of 18 miles and contains 27 towns, which are supplied with light and power. Most of the towns, i. e., all the smaller ones where there is no great use of power, contain each a transformer sub-station for supplying the current for lighting and power purposes. The larger towns which consume not only much light, but also much power at an irregularly varying load for agricultural purposes, have separate lighting and power circuits. The sub-stations in these towns contain storage batteries which are charged by motor-generators. During the day the batteries are charged and supply at the same time current to the few burning lamps. During the night the battery and motor-generator operate in parallel. Power is used especially for thrashing. The motor is placed on a carriage in order to connect it easily with any machine to be driven. To take current from the high-tension circuit on the open field, a portable transformer on a carriage is used.—*Elek. Zeit.*, Nov. 28.

Steam Generator.—BRABY.—A communication in which he explains the essential difference between his system of producing steam, and that of an ordinary boiler. Water is a bad conductor of heat, and heat can only be distributed in water by circulation. When circulation is perfect the steam bubbles are detached from the surfaces as fast as they are formed, and the maximum economical effect is obtained from the fuel. He considers circulation to be defective and slow, when it depends only upon the convection currents due to gravity. A boiler of ordinary construction is considered as a shell of metal, which is a good heat conductor, partly filled with water, which is only capable of distributing heat by circulation, yet the only circulation made use of is that caused by gravity, which necessitates a more or less large quantity of water being used to give passage for the convection currents and to provide a surface for ebullition. His steam generator is described as one or more plates or blocks of copper or other good heat conductor, having waterways formed therein, through which water is forced to circulate rapidly while under the application of heat. The temperature is equalized throughout the blocks by the heat-conducting power of the mass of metal, through which the water circulates with sufficient rapidity to carry away the heat and to prevent corrosion. No more water is brought into contact with the heating surfaces in a given time than can be converted into steam within that time, there is no surface for ebullition, prim-

ing is an impossibility, and there can be no danger of explosion. He claims that his method of converting water into steam is scientifically correct; that by it he has increased the evaporation efficiency of a square foot of heating surface as 5 is to 1, compared with the results obtainable from ordinary boilers, water tube and otherwise. Economy of fuel is also assured, and perfect immunity from explosion.—Lond. *Elec.*, Dec. 13.

TRACTION.

High-Speed Railways.—An editorial note on the results of the experiments of the German society for the study of electric high-speed railways. It is remarked that the speeds obtained thus far—maximum 100 miles per hour—are not record breaking, as the same speed and even 102.8 miles has been obtained on American steam railways. In this comparison it must be borne in mind, that the American records were all made by regular passenger trains which could hardly be classed as light, while the German records were obtained with specially designed experimental cars. "If any one desires to operate a train schedule at speeds of 80 to 100 miles per hour or even more, and is willing to run such light cars as those which the German experimenters are using, there are plenty of American locomotive designers who can produce a machine to meet the requirements.—*Eng. News,* Dec. 26. (A criticism of the Zossen experiments based only on the maximum speed actually obtained is unfair. The real value of the experiments lay in the test of a type of electrical equipment for traction service involving a great delivery of energy, and the result demonstrated the entire practicability of electric power for any railroad service, and particularly for express service.)

Shallow Underground Tramways.—WORDINGHAM.—An article on the report of Baker and Rider to the London County Council, on the Boston and New York shallow underground tramways, which has already been mentioned recently in the Digest. Some critical remarks are added on special points of the report. While the report points out the advantages of shallow subways over deep level tubes, the present writer says that the essential feature of the shallow subways is that they provide a means of affording nearly all the advantages of a quick service of tram cars in crowded streets; i. e., they run at moderate average speed with very frequent stopping places, whereas the deep-level tubes afford rapid transit between extreme points with comparatively few stops on the way. There is no doubt that there is a great advantage of running the trams in subways instead of on the surface in crowded thoroughfares. The report expresses astonishment at the fact that no provisions has been made either at Boston or New York for the accommodation of pipes in the tram subways. The present writer denies that the subway is really a solution of the problem of placing pipes. It is true that it would be effectual so far as trunk gas mains, electric feeders, etc., are concerned, but there would always remain the danger of serious explosions in the event of the gas escaping. On the other hand, it is the distributing mains, whether of electric energy or gas, or of water, that present the real difficulty; and it is difficult to see how a subway is to enable attachments to each system of mains to be made from every house on both sides of the street.—Lond. *Elec. Rev.*, Dec. 13.

Electrification of Railways.—DAWSON.—An article in which he says that the problem of the electrification of our railways is at present concerned, not with the high-speed main line trains, but only with the heavy suburban traffic. In this respect a large amount of experience has been obtained. A table is given with some data relative to the installation of several such railways in America and Europe. In this case the most important point is to get as high an acceleration as possible with due regard to the comfort and safety of the passengers, because if the acceleration can be increased in short distance runs the average speed of the train is increased, and with the same factor of safety as regards running, the number of trains can be increased. The maximum acceleration for traffic of this sort, which seems to be possible on steam railways, is 9 inches per second per second. Electrically, it is quite feasible, although not advisable, either economically or for reasons of safety, to exceed an acceleration of 24 inches per second per second. Regarding the electrifying of our railways, he says that the conductors cannot be overhead as long as a combined steam and electric service is run over the same lines, because the deposits formed on the wires would cause serious sparking. If the conductors are on the ground, they must be protected so as not to be easily accessible to the employes. At the same time the voltage used should be such as not to be fatal should any one come in momentary contact with them. The ideal method of operating an electrical suburban service would be to have a light structure on which the electric train would run, elevated above the existing lines. At junctions, the lines would be run over or under each other in such a way as to totally avoid crossing on the level. At the termini, loops might be provided. This would enable the trains to follow each other continuously, and the danger of collisions could be greatly reduced. Should this "double story" line be impossible, which is the case as long as steam trains are run under it, separate lines should be provided for the electrically operated trains, so as to reduce the delays to a minimum.—Lond. *Elec. Rev.*, Dec. 13.

Storage Batteries in Traction Systems.—An article in which attention is called to the fact that storage batteries are largely used for traction plants in the United States and Continental Europe, but are only beginning to make headway in Great Britain. The use of batteries in traction systems is discussed. It is said that the practice of connecting a battery of such a number of cells as will give the average voltage of the power circuit at the point where the battery is located, in parallel with the load, seems to be rapidly disappearing in favor of a smaller number of cells discharging through a booster. This enables a smaller size of battery to be installed. The fluctuations in load are taken up by the booster for charging the battery. The watt-hour efficiency of the battery is very considerably improved, being as high as 85 to 90 per cent when working under these conditions. This is due to the fact that, when working through a reversible booster on a traction load, the discharge is followed so rapidly by a charge that the average e. m. f. per cell is more than 2 volts, even on a heavy discharge. By this means the battery at the end of the day's run is practically fully charged and ready for the night load. Another advantage is the absence of any regulating cells.—Lond. *Elec. Rev.*, Dec. 13.

Conduit Systems in England.—A brief article stating that the conduit system will be used by the Bournemouth municipality for a length of 3 miles, and by the London County Council for 16 miles. At Bournemouth the side slot will be used, the width of the slot being inch and 1⅛ inches, the latter occurring on the curves. There will be a combination of the conduit and overhead trolley construction, as about 14 miles of overhead structure are to be installed at the extremities of the conduit tracks. The London County Council will use the conduit system throughout for 16 miles, the center slot being used, the width of the slot being ¾ inch.—Lond. *Elec. Rev.*, Dec. 13.

REFERENCES.

Machinery and Equipment for Electric Traction Systems.—A very large number of illustrated trade notes of British manufacturers, filling 35 full pages, including the following: Willans-Lancashire steam sets for tramway power stations; car lifting jacks; Ferranti-Westinghouse generators for Manchester tramways; Browett-Lindley engines for traction; engines for the Sheffield tramway power station; work wagons for heavy castings; Willans engines for electric traction; Doulton conduits and troughs; car heating, switchboard equipment, electric locomotives; storage batteries; instruments; traction accessories, etc.—Lond. *Elec. Rev.*, Dec. 13.

Train Control.—The first part of an illustrated article by Sprague on his multiple unit system, as applied to the Boston elevated railway. An illustrated description of the master control system of the British Thomson-Houston Company, as used in the Great Northern & City Railway, and an illustrated article on the Westinghouse electro-pneumatic system for the control of electric trains.—Lond. *Elec. Rev.*, Dec. 13.

Traction Plant.—An anonymous article on "Economy in plant for traction stations." As an example, the general design of a station is given, in which it is proposed to run a service of 27 cars with a load factor of 33 per cent. Two different designs are given, one with and the other without a storage battery. The differences between the two schemes are shown.—Lond. *Elec. Rev.*, Dec. 13.

Track Construction.—An illustrated article on the substantial system of street railway track construction at Scranton, Pa. This track comprises a concrete base, T-rails, steel ties, and reinforced joints, with brick and asphalt paving.—*Eng. News*, Dec. 26.

INSTALLATIONS. SYSTEMS AND APPLIANCES.

Installation of a Meat-Packing Plant.—An illustrated description of the electric installation of a large, new Chicago meat-packing plant. The power house contains two 250 generators, giving 1000 amperes direct current at 250 volts. There are 16 lighting circuits and 16 power circuits. Practically all the machines and apparatus throughout the plant are operated by means of 230-volt direct-current motors, there being altogether 50 motors with an aggregate capacity of 1023 hp. The lighting system is also operated at 230 volts, there being 2000 incandescent lamps of 16 cp and 100 enclosed arc lamps of 6 amperes.—*West. Elec.,* Dec. 21.

Five Thousand-Ampere Switch.—An illustrated description of a great four-pole switch, installed in the power house at Willesden. It weighs about a couple of tons. It is used for joining up the bus-bars in the station and works on two phases. There are really four separate switches, and each is mounted on a marble base 30 inches by 13 inches by 3 inches. They are all operated simultaneously by worm gearing from a handwheel, the shaft being divided into sections between which are inserted insulating couplings, each worm is, of course, also insulated from the switch that it actuates. Stencil copper brushes built up to give a sectional area of 16 square inches are used for contact.—Lond. *Lightning,* Dec. 12.

ELECTRO-PHYSICS AND MAGNETISM.

Electrification of Air.—LEHMANN.—An account of an exhaustive study of the distribution of electrified air in a large room. He claims to show that the convection of electricity from a point, during glow discharge, cannot be attributed to a conductivity of the air itself. He reproduces a large number of diagrams showing the distribution of the equipotential surfaces round the point, and this distribution is essentially different from what it would be in the case of a bad conductor like water. A charged conductor brought into a current of electric wind does not lose its charge if the electrifications are of the same sign, even though its own potential be much higher than that of the electrified air. If the conductor is positively electrified, it will lose its charge and assume the potential of the surrounding negatively electrified air. This fact is of vital importance in the use of probes generally, as they do not indicate the surrounding potential unless they are previously discharged. The electrification of air cannot be due to electrons, neither can it be due to dust particles.—*Ann der Physik,* No. 12; abstracted in Lond. *Elec.,* Dec. 20.

Fatigue of Luminosity.—SCHMAUSS.—The reversible cross, first exhibited by Crookes, has been explained on three distinct theories. One is heating, the other chemical change, and the third is precipitation of metallic particles which are detached from the cathode. While the first can only explain a temporary change, and the last only a permanent change, a chemical effect might either produce a permanent or a reversible change. He made some experiments from which he concludes that the temporary fatigue observed in the case of most substances is due to heating under the influence of cathode rays. As regards the permanent fatigue he distinguishes two classes of substances; in the first, to which Balmain's luminous paint belongs, the permanent fatigue is due to changes produced by heat. The substances turn brown, just as they do in heating above a certain temperature. The fatigue sets in in ten minutes in the case of luminous paint, but requires several hours in the case of chalk. This shows that the fatigue cannot be due to the deposition of metallic particles, since these would affect all bodies equally. The temperature of the maximum of luminescence lies at 70 degs. for Balmain's luminous paint. Eggshells and glass shine the brighter the lower their temperature.—*Phys. Zeit.,* Dec. 1; abstracted in Lond. *Elec.,* Dec. 13.

Drop of Potential at the Electrodes in Vacuum Tube Discharges.—SKINNER.—A very high potential is required to force a discharge directly through a rarefied gas across the space between the electrodes, when these are brought within a certain small distance of each other. This potential is due to a drop at the electrodes. He gives an account of a complete investigation of the conditions existing at the two electrodes. A special result obtained by him is interesting. Of two metals in the same gas the one showing the greater drop of potential as cathode possesses the smaller drop of anode.—*Phil. Mag.,* Dec.

Magnetic Elements in France.—MATHIAS.—The law of variation of the horizontal component of the earth's force formulated by him for the Toulouse district, has since been shown to apply to the whole of France and to represent the observed elements within the limits of observation. He has tried to find similar laws for the distribution of declination and dip, but has not met with the same success.—*Comptes Rendus,* Nov. 25; abstracted in Lond. *Elec.,* Dec. 13.

Temporary Set and Magneto-Striction.—BARUS.—A long paper, illustrated by diagrams, on the "Temporary set, as associated with magneto-striction." He believes the phenomenon of magneto-striction to be inherently associated with what he interprets as viscosity. In other words, if deformations evoked by physical charges of molecular configuration within the metal, be termed viscous, whether gradual or sudden, then viscosity enters essentially into magneto-striction. With each twist, however small, and within the elastic limits, the wire receives a certain amount of set, instantaneously. The whose of this set may be shaken out by the first magnetization, and it is thus called temporary, to distinguish it from the permanent set which comes much later, as a second phase lying beyond the limits of elasticity. On removing the magnetic field, therefore, the unmagnetic wire is molecularly different from the same unmagnetic wire before magnetization, and the new molecular arrangement is permanent so long as the twist is unchanged. He gives an account of a series of experiments which show the dependence of temporary set on the antecedent strain. He first experimented with successively increasing alternating twists and then with successively increasing, asymmetrically alternating twists. Apart from its inherent importance as an introductory phase of permanent set, he believes temporary set to have the additional interest of being a clear cut instance of purely mechanical hysteresis, without necessary relation to magnetism.—*Phys. Rev.,* Nov.

REFERENCES.

Light Pressure.—NICHOLAS and HULL.—A preliminary communication on the pressure of heat and light radiation. They give an account of experiments which prove qualitatively the existence of a pressure, not due to gas molecules, of the nature and order of magnitude of radiation pressure.—*Phys. Rev.,* Nov.

Colored Rings Due to Cathode Rays.—VON CZUDNOCHOWSKI.—An account of a continuation of his experiments on the colors produced by cathode rays on plates of fluorspar. He tested the influence of the geometrical form of the cathode.—*Phys. Zeit.,* Dec. 1; abstracted in Lond. *Elec.,* Dec. 13.

Construction of Electromagnets.—CONOR.—A symmetrical outline of the calculation of electromagnets for other purposes than in dynamos and motors.—*L'Elec.,* Nov. 30.

ELECTRO-CHEMISTRY AND BATTERIES.

Conductivities of Solutions.—F. KOHLRAUSCH.—One of the fundamental quantities in electrolysis is the temperature coefficient of ionic friction in water (the change, with the temperature, of the "mobilities" of the ions). He discovered some striking relations between the figures hitherto accumulated, chiefly through the work of Deguisne, and these relations make the facts of electrolysis appear in a new and comprehensive light. The ratio of the conductivity of very dilute aqueous solutions at the temperature t (deg. C.) to the conductivity at 18 degs., is, according to Deguisne, equal to

$$1 + a\,(t - 18) + b\,(t - 18)^2$$

In attempting to find the conductivities of infinitely dilute solutions, he encountered the difficulty that there is a considerable change between dilutions of 0.001 and 0.0001 gram equivalents. This change is due to the conductivity of pure water, and he himself, therefore, introduced a correction based upon his own experiments. He then found that the second coefficient, b, could be expressed in terms of the first, a, by the equation,

$$b = 0.0163\,(a - 0.0174).$$

In this equation the two numerical values are nearly equal, and no great error is introduced by making them equal. If this is done, a very important result is obtained by exterpolation. It is found that for a certain temperature all the conductivities of aqueous solutions must be zero. This temperature is — 39 degs. C. He proposes to examine this result by testing under-cooled solutions. He believes that this temperature represents the "limit of the liquid state of

water," apart from crystallization. Another conclusion which he arrives at is that the electrolytic mobility of monovalent ions in water is determined by their mobility at a single given temperature.—*Sitzungsber. Akad. Wiss. Berlin,* Oct. 31; abstracted in Lond. *Elec.,* Dec. 20.

Copper-Cobalt Alloys.—REICHARDT.—An account of an investigation of the electrical properties of alloys of copper and cobalt. The electrical properties of copper are greatly influenced by the addition of small quantities of cobalt. For small additions of cobalt the influence is about the same as that of manganese, and three times that of nickel. An addition of 3 to 5 per cent brings down the temperature coefficient of the alloy to a minimum at + 0.00077, and at the same time yields the maximum thermo-electric force against pure copper with 33 microvolts per deg. C. Meanwhile, "the specific resistance increases to 9.5 microhms," and is only slightly increased by farther additions of cobalt. On the other hand, a slight addition of copper to cobalt considerably modifies the electric porportions of the latter. At a point lying between 0 and 10 per cent of copper the specific resistance reaches a maximum and the thermo-electric force a minimum. On the whole, the results do not show any discovery of great practical importance. But an alloy of copper with 1 or 2 per cent of cobalt may possibly be useful for thermopiles, since it combines a high fusing point, a high thermo-electric force ,and a resistance only four times that of copper.—*Ann. der Physik,* No. 12; abstracted in Lond. *Elec.,* Dec. 20.

Polarization Capacity of Platinum.—SCHOENHERR.—An account of an investigation of the polarization capacity of cells containing 0.1 normal sulphuric acid, as free from gas as possible, the electrodes being pieces of platinum foil of 6 sq. cm. area, kept at a distance of 0.6 cm. apart by means of glass beads. After the cell is charged, the capacity is found to fall regularly from 77 to 44 microfarads after 72 hours. At the same time the apparent resistance increases. When the cell is heated, the capacity rises from 41 microfarads at 20 degs. to 45 at 60 degs., and then falls to 40.5 at 79 degs., while after cooling the value is 25.6 microfarads at 17.2 degs. Repetition of this treatment lowers the capacity still further to 22.2. These results are explained by the diminution of the gas content at the surface, between the platinum and the electrolyte, brought about by the heating. By passing hydrogen over the surface of the electrolyte in the cell, and turning the latter, so that the platinum plates come into contact with the gas, the capacity is increased from 20 to 33.4, while treatment with oxygen in the same way has no effect. When by means of an auxiliary electrode placed in a beaker of the electrolyte surrounding the cell, so that the liquids inside and outside the cell are in communication, electrolyte hydrogen or oxygen is evolved at the surface of the electrodes, the capacity rises to 73.8 microfarads, a number almost equal to its initial value. The capacity of the cell with bright platinum electrodes is practically independent of the frequency of the alternating current, but when the electrodes are acted upon by a constant polarizing force, it is found that for different frequencies the capacity is approximately inversely proportional to the square root of the frequency. About 20 hours after the removal of the polarizing force the cell returns to its original condition, in which the capacity is almost independent of the frequency. The removal of gas from the surface of platinum can be effected by igniting the plates, and in this way results are obtained similar to those produced by heating the whole cell.—*Ann. der Physik.,* Aug.; abstracted in *Sc. Abstr.,* Nov.

REFERENCES.

Metallic Carbides.—MOISSAN.—An article in which, after an historical introduction, he gives as summary of the different metallic carbides, dividing them into those which are not soluble in water and those which are.—*Rcv. Gen. des Sc.,* Nov. 15.

Thermo-Chemistry of Very Dilute Solutions.—STEINWEHR.—An account of an experimental investigation of the heat evolved by the dissociation of various acids, and of the temperature coefficient of the heat of dissociation.—*Zeit. Phys. Chem.,* Aug. 23; abstracted in *Science Abstracts,* Nov.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Permeameter for Testing Magnetic Quantities in Bulk.—An abstract of the discussion which followed Drysdale's paper, recently abstracted in the Digest. Generally the opinion was expressed that the instrument would supply a long-felt want in practice. But more experiments are needed concerning the accuracy of the instrument. Walker said that one had to rely upon the e. m. f. of the battery being absolutely constant. He suggested making a scale which gives different values for different values of the e. m. f. of the battery, then it would be a small matter to take the voltage of the battery before the test and read the values off the scale. Perry suggested to cut away the pin left by the drill and turn it up a little smaller, annealing it if necessary. By making a very slender pin it was possible to get over all sorts of difficulties as to joints. It would also entail less waste of material all over the casting. Drysdale, in his reply, agreed that there were difficulties still to be confronted. The apparatus did not give the same result as the older methods at low induction densities, yet so far as he could see, if there was an air-gap effect it was one which was most remarkably constant. He had found throughout his tests that he could put the plug in and take it out several times, and the results were remarkably consistent. If this were so, he did not think that it affected the use of the instrument from a commercial point of view. The whole point turns on the drilling, and this is a critical matter.—Lond. *Elec.,* Dec. 20.

Electroscope.—HURMUZESCU.—A description of an electroscope which has three metal sheets 2 mm. apart. On the outer two are hung two gold leaves. Beneath these three sheets, and in electrical communication with the case of the instrument, are two similar sheets, which can be moved up between the three sheets so as to form a condenser, or moved away from them. When the electroscope is to be charged, the two sheets are moved up so that the capacity of the electroscope is large, then if the voltage be too feeble to diverge the leaves, the two sheets are lowered, diminishing the capacity and increasing the pressure till the leaves diverge.—*Ann. Sci. de l'Un. de Jossy,* March; abstracted in *Science Abstracts,* Nov.

TELEGRAPHY. TELEPHONY AND SIGNALS.

Wireless Telegraphy Over the Ocean.—Some editorial notes on Marconi's achievement, which is said to be a germ that promises to develop into "abundantly fruitful maturity," but in another direction than is thought by the general public. "It is not in the interlinking of continents divided by an ocean, but rather in the overspreading of the ocean itself with telegraphic facilities that the power and fruitfulness of this latest achievement of Mr. Marconi is to be perceived. Submarine cables already link ocean-divided continents far better than wireless telegraphy can ever do." The true field of wireless telegraphy is across comparatively short distances of water. "It is really a disadvantage to wireless telegraphy to be able to take in such a wide compass as an entire ocean. Indeed, when such immense areas are covered, the probabilities of confusion and clashing of signals is a thousand-fold increased." No serious competition with submarine telegraphy can ever take place on a commercial basis, at any rate until the Marconi system is evolved into something very different from what it is now. Wireless signals in the ether can never be secret; it will always be possible to intercept them.—Lond. *Elec.,* Dec. 20.

Thermopiles in Telephone Stations.—TUCH.—An article on the experiments made by the German Post Office with Guelcher thermopiles as a substitute for primary or secondary batteries in telephone stations. Thermopiles of 50 junctions, giving 3 volts, and of 66 junctions, giving 4 volts, were tried. Curves are given showing the variation of volts, amperes and watts as the number of microphone circuits increased, for storage batteries, primary cells, and different arrangements of thermopiles. It was found that the thermopiles, owing to their high internal resistance did not furnish a corresponding amount of energy, as the number of microphone circuits was increased, and that their first cost, upkeep, and the cost of gas far exceeded the cost of accumulators. The thermopiles are now relegated to the Post Office Museum.—*Archiv. Post. Tel.,* July; abstracted in *Science Abstracts,* Nov.

REFERENCES.

Wireless Telegraphy.—An illustrated description of the Slaby-Arco portable field equipment for wireless telegraphy. Their tuned system has been described before at length in the Digest.—*Sc. Amer.,* Dec. 28.

German-American Cable.—An illustrated description of the construction of, and the instruments used, on the German-American cable between Emden, Fayal and New York, which has been in successful operation for one year.—*Elek. Zeit.,* Dec. 5.

Statistical.—The first part of a long article on the telegraph and telephone cables of the German Empire; comparative statistical tables on telegraphy in various countries in 1900 (the United States not being included), and a statistical article on telegraphy and telephony in the colony of Victoria in 1900.—*Jour. Tel.,* Nov. 25.

Electric Clocks.—DARY.—An illustrated article on electric clocks, exhibited at the Glasgow Exhibition.—*L'Elec.,* Oct. 23.

MISCELLANEOUS.

REFERENCE.

Lightning Rods.—NEESEN.—An article in which he describes several instructive cases of lightning flashes and gives conclusions regarding the proper construction of lightning rods.—*Elek. Zeit.,* Nov. 28.

New Books.

DIE NEUSTEN FORTSCHRITTE AUF DEM GEBIETE DER FUNKENTELEGRAPHIE. By Professor A. Slaby. Berlin: Julius Springer. 30 pages, illustrated. Price, 80 pfennige.

This is a somewhat elementary but interestingly written paper upon the principles of wireless telegraphy, or, as the author calls it, "Spark Telegraphy." The writer is of a somewhat imaginative disposition, to judge from the statements made in the opening paragraph concerning the faculties apparently possessed by Oriental races for becoming acquainted with distant events in a time too short for the dispatch of news by the ordinary means of transmission. Thus it is stated "The death of General Gordon was known in the streets of Cairo on the day of its occurrence, although the telegraph lines were destroyed." The facts in connection with the elementary theory of wireless development are, however, set out in an interesting and thoroughly scientific manner, together with some of the details through which the Slaby system of wireless signaling, now used to some extent in Germany, has been developed. The pamphlet is well worthy of the attention of all readers interested in the subject of wireless transmission.

ELEKTRO INGENIEUR KALENDER 1901. Von Arthur H. Hirsch und Franz Wilking. Berlin: Oscar Coblentz. 173 pages, illustrated, with detachable note book. Price, 2.50 marks.

This is the first edition of a new electrical "almanac," as the Germans like to call a "pocketbook" which is published annually. It is smaller in size than Uppenborn's, which has been well known among German electrical engineers for many years. In its contents and scope the new publication also differs distinctly from Uppenborn's, so that it may be expected to hold its place successfully by the side of the older one.

The book is intended to give easily found, reliable information about all important questions of electrical engineering. This information is given in condensed form, there being very many tables of useful practical data. The authors have especially endeavored to give such data which the engineer needs while away from his office. The reviewer has found, while using the book for a while, that the data seem to be reliable and have been collected with care.

After 20 pages of mathematical tables, a comparative table of the measures and weights of different countries is given, followed by a table of specific gravities. The following chapters deal with the building of electric stations; the choice of power, such as water power, gas or steam; choice of prime movers, gearings, electric generating station, wiring, installation at the consumers' terminals, light and power, motors required for driving different machines, in sugar plants, in workshops, pumps, ventilators, elevators, brewery machines, in wood workshops, in brick kilns, on farms, in printing plants; electric traction. Some rules and regulations, issued by German authorities and societies, follow.

The arrangement of the single chapters seems very practical. The engineer is thought to be called in to give his opinion regarding the installation, say, of electric pumps. On the four pages of the "almanac," dealing with this subject, he finds the most important formulas for different kinds of pumps, several practical tables of numerical data, with a brief explanatory example, and a series of questions which must be answered in order to give a complete opinion and specification. The arrangement of the advertisements (40 pages) is ingenious. They are made a part of the book, and are arranged uniformly, as they give throughout standard sizes and prices of the manufacturer. Each chapter of the book has a little note, "for prices see advertisements, pages ——," so that the engineer is at once enabled to find out quickly the cost of what he wants to install.

Although much information, especially regarding prices, is based solely upon German conditions, and would not apply to the conditions of this country, there is no doubt that the American engineer will find in this little book much that is useful to him. The size of the book is such that one can easily carry it constantly in the pocket.

DIE BELEUCHTUNG VON EISENBAHN-PERSONENWAGEN. Mit Besonderer Berucksichtigung der Elektricitat. By Dr. Max Buttner. Berlin: Julius Springer. 134 pages, 60 illustrations. Price, 5 marks.

This book gives a review of the methods of train lighting, and more especially of the various electrical systems which have been devised for this purpose. The author believes the public has a right to demand a system which will enable the passenger to read comfortably in the car, but the railroad companies do not seem to be in general of this opinion. Any oculist will say, however, that reading in a railroad car under the present conditions of lighting is unsafe, and it is certain that an improvement of these conditions will come from a general introduction of electric train lighting.

The author gives first a brief historical introduction. Figuratively, he starts from Adam and Eve—that is, from an edict of the King of Prussia, issued in 1844, and ordering the railroad cars to be lighted during the night "for the sake of safety and decency." Before that time there had only been signal lamps at the front and rear ends of the train. The first two chapters of the book (17 pages) deal with the methods of lighting with candles, oil, petroleum and gas. The balance of the book (117 pages) deals with systems of electric lighting of trains. As an introduction to this part of the book the author describes in the third chapter the construction and treatment of storage batteries.

The fourth chapter deals with the lighting of a total train by dynamos and batteries. The following systems are described: Stroudley and Houghton, used on the London-Brighton & South Coast Railway; that of Langdon, tried on the Midland Railway in England; that of Dietrich, tried on the railways of Wuertemberg, and that of Dick. The Dick system is described in detail. The fifth chapter deals with the lighting of single railroad cars by means of dynamos and batteries. The systems of Stone, Dick, Moskowitz, Vicarino and Aubert being described. The sixth chapters deals at some length with those systems of train lighting in which no dynamo is on the train, but the lighting current is furnished by storage batteries alone. Many of the systems described in these three chapters are well illustrated by diagrams.

In the seventh chapter the author gives some general notes on electric train lighting, and discusses briefly the relative advantages of the different electric systems. He says that the number of railroad cars at present lighted by electricity is 12 000, of which 5500 cars get the current from a combination of dynamo and storage battery, while 6500 are provided with batteries alone. In Continental Europe the pure storage battery system is preferred, in other countries a combination of dynamo and battery; in England, for instance, the Stone system is much used. The author believes that the Nernst lamp will not be introduced in railroad cars, as it cannot be made for voltages below 70. He seems to hope much from the Welsbach osmium lamp, as it is well suited for low voltages. He remarks that the German Incandescent Gas Light Company, which owns the patents for Germany, expected to put the osmium lamp on the market in the autumn of 1901. In view of the fact that nothing has been heard of the osmium lamp for quite a while, one is tempted to ask, What has become of it?

In the eighth and last chapter the author discusses the advantages and disadvantages of the different methods of train lighting, especially of gas and electricity. He also gives an estimate of the first cost of installation and of the cost of operation for the different systems. He concludes that the future of train lighting certainly belongs to electrictiy.

The book, as a whole, can well be recommended, especially to railroad engineers who desire to be posted on the subject of train lighting, which is certainly a subject of timely importance. While the author does not seem to give much that is new, his book is a fair and plain review of the subject. The descriptions are clear and concise. Print and illustrations are good.

MESURES ELECTRIQUES. Lecons Professees a L'Institut Electrotechnique Montefiore. By Eric Gerard. Second edition. Paris: Gauthier-Villars. 532 pages, 217 illustrations. Price, 12 francs.

The first edition of this work was published in 1896 and attracted the attention of American readers who were already acquainted with the author's earlier book, *Lecons sur L'Electricite*, which was subsequently translated and published in this country, with the addition of several chapters by American authors. The "Mesures Electriques," by Gerard, proved to be no mean successor to the classical volumes of Mascart and Jubert, and it confirms the reputation of French writers as distinctly excellent in the elegance of their presentation of the theory of electricity and magnetism in its applications in measurements.

To those not familiar with the former edition of this book, its character may largely be inferred from the statement in the preface: "The progress of applied electricity has been rapid because the electricians trained in laboratory methods have applied in their subsequent work the rigorous methods of investigation which characterize physical research." An American reader receives a statement of this character with certain qualifications. The workshop and testing rooms of certain of our electrical manufactories have usually gone in advance of laboratory investigations and scholastic instruction, and the gravity of the French professor's attitude toward his subject matter, seems to be ill warranted.

In general this most excellent book is characterized by a lack of technical taste or judgment, though for a French electrician these strictures would have less weight. The book is evidently a compilation from materials used with schoolboys in their studies, and suffers somewhat from lack of sympathy with the needs of the practicing engineer. Upon reading this second edition it is noticeable that the whole work has been conscientiously re-edited, and that many parts have been rewritten and considerable new matter has been added. These changes have generally resulted in added precision of statement (though this is a hobby gallantly ridden by many scientists) and symmetrical treatment.

The introductory chapter on principles of measurement and the limits of error is one of the best discussions of the subject matter that has been presented. The same is true of Chapter III., which deals with photometry, which, in this later edition, has been revised and brought fairly up to date. The subject of galvanometry is rather thoroughly discussed, and the treatment is unusually clear, though at the present rate of elimination of the galvanometer *per se* from applied electrical measurements, the subject is overtreated. In this same connection an illustrated description of many commercial forms of ammeters and voltmeters is given without any adequate analytical statement of the mechanics of their action. Noticeably again, in Chapter XVI., the same vague descriptive treatment is given to the various integrating electricity and energy meters. These descriptions are aggravated cases of the infliction of catalogue matter within the dignity of book covers. It is surprising that the author has not availed of several very complete and elaborate articles in which these various types of instruments are analytically treated; the engineer would not object, and the schoolboy would be vastly profited.

The testing of iron for permeability and hysteresis receives a fairly good treatment, though it suffers by omission of recent developments in apparatus and methods. Following this, some three chapters are given to tests of motors and dynamos, of direct, alternating and polyphase types, and here the author is rather more successful, though much of his practice would not be followed in this country. Finally, a chapter is awarded to testing transformers, and through its 15 pages the discussion is so insufficient that the matter is practically valueless.

The work of M. Gerard has two pronounced faults: One occurs through ignoring foreign methods, which in so many instances are in advance of the practice he describes, and the second happens through an almost total absence of references.

For the physicist, the schoolman or the scholarly engineer *Mesures Electriques* will prove an unusually suggestive book from its clearness of presentation where analysis is used. Had the author confined himself to those academic mathematical subjects with which he has shown he is so vitally conversant, a symmetrical work would have resulted. But, unfortunately, through an endeavor to be practical, he has ventured into subjects with which he evidently has only a tentative familiarity.

Though the importance of this French work scarcely merits such an extended review for American readers, its shortcomings are pregnant with suggestion and they have been emphasized in detail. As we turn away in disappointment from one work after another on electrical measurements, each one in turn has shown no more clearly what its successor should be, and the net gain has been small.

Westinghouse Standard Transformers.

We illustrate herewith the Westinghouse O. D. type of transformer and give some curves showing its efficiency, and also some temperature curves. This transformer is of the shell type, which type the manufacturers consider to be much superior to the core type, owing to the less voltage that exists between adjacent layers and the greater facilities offered for the conduction of heat from the core. In a comparison made between these two types, the voltage between the first turn of the first layer and the last turn of the last layer is stated in the core type to amount in a particular case to 500 volts, while in the shell type it is but 50 volts. A marked advantage of the lower temperature of the shell type is that there is less aging of the iron of the core.

A feature that has been introduced into the design of these transformers is a system of connections whereby an unusually large number of ratios of transformation may be obtained. For example, a lighting transformer for a 2100-volt primary circuit admits of the following secondary voltages: 52½ — 105 — 210; 55 — 110 — 220; 58 — 116 — 232. The standard Westinghouse method of cross connecting the secondaries has been retained in these transformers. This is a method devised to overcome the large difference in voltage between the two sids of the circuit when they are unequally loaded.

When the rated primary voltages are 1050 or 2100, the transform-

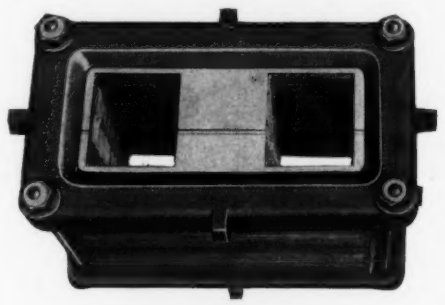


FIG. 1.—SHELL OF TRANSFORMER.

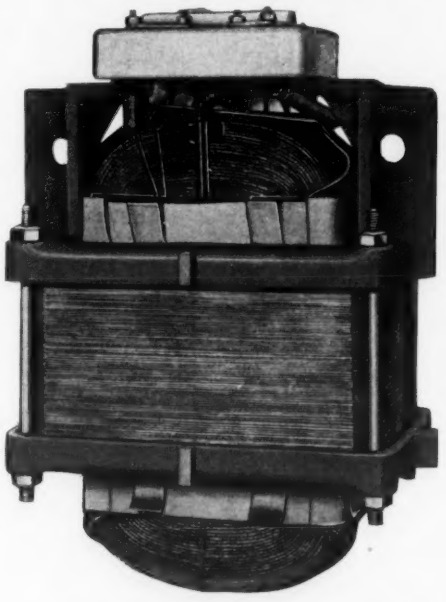


FIG. 2.—TRANSFORMER READY FOR CASING.

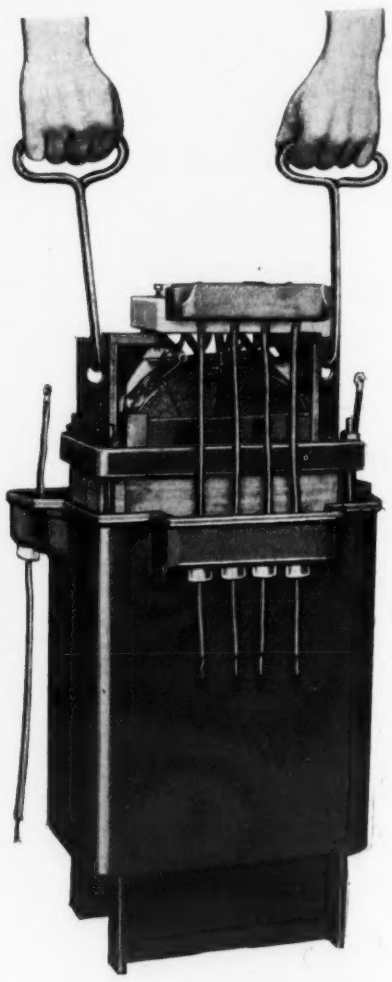


FIG. 3.—LIFTING TRANSFORMER OUT OF CASE.

ers will operate satisfactorily at any e. m. f. from 950 to 1150 volts, or from 1900 to 2300 volts. The 60-cycle transformer will operate at

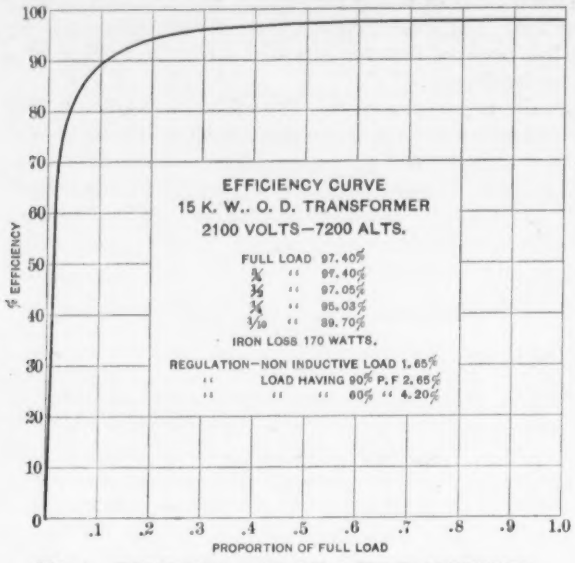


FIG. 4.—EFFICIENCY CURVE FOR 1-KW TRANSFORMER.

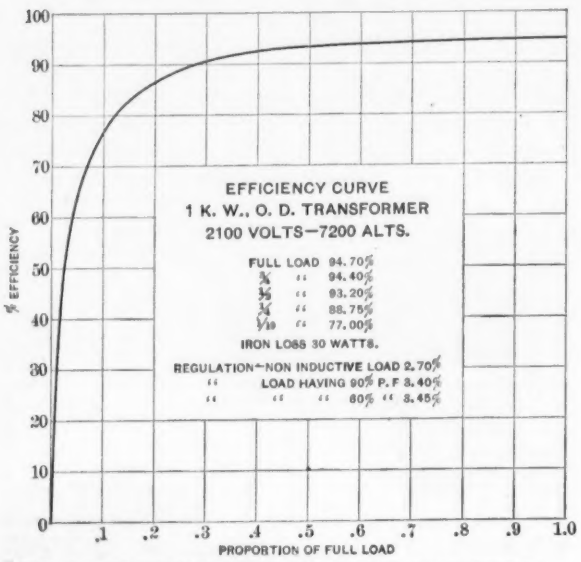


FIG. 5.—EFFICIENCY CURVE FOR 15-KW TRANSFORMER.

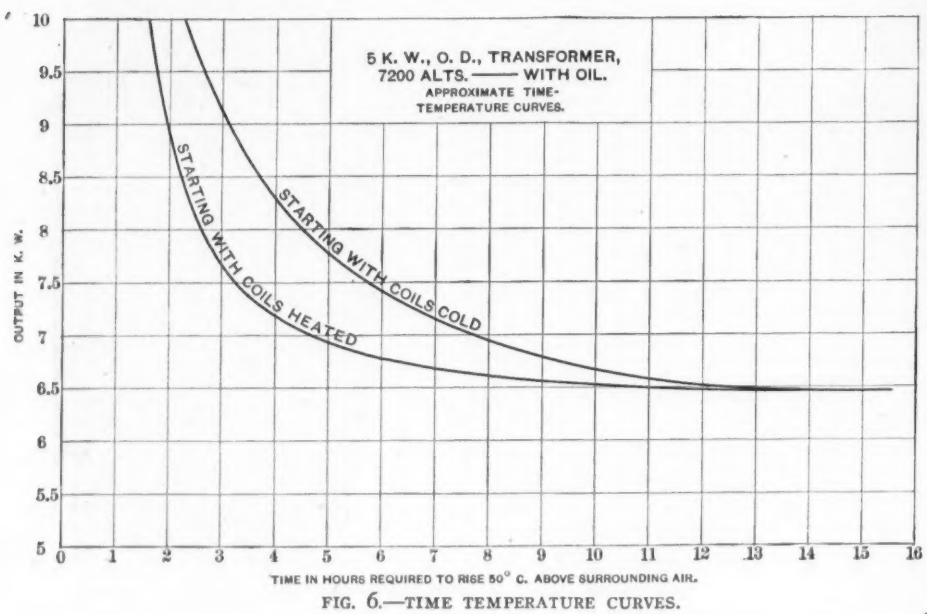

5 K. W., O. D., TRANSFORMER,
7200 ALTS. —— WITH OIL.
APPROXIMATE TIME-
TEMPERATURE CURVES.
STARTING WITH COILS COLD
STARTING WITH COILS HEATED
OUTPUT IN K. W.
TIME IN HOURS REQUIRED TO RISE 50° C. ABOVE SURROUNDING AIR.

FIG. 6.—TIME TEMPERATURE CURVES.

any frequency from 40 to 133 cycles, and the 25-cycle transformers will operate on circuits of a frequency up to 40 cycles.

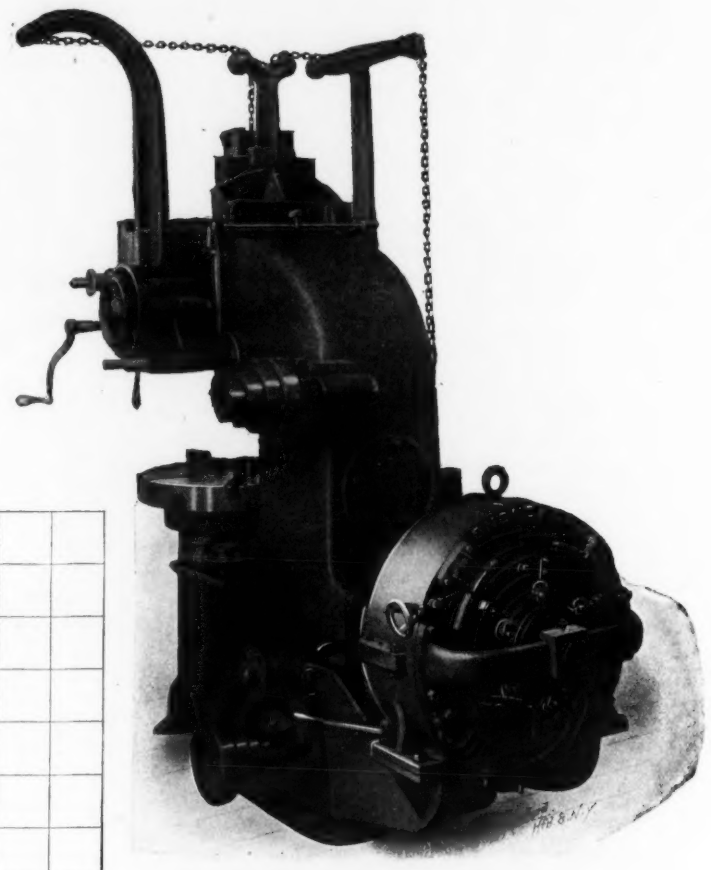
Of the efficiency curves shown, that of Fig. 4 is for a 1-kw transformer and that of Fig. 5 for a 15-kw transformer. It will be noted that the efficiency of the small transformer is 94.7 at full load and drops to only 88.75 per cent at quarter load, while the efficiency of the larger transformer is 97.4 at full load, and no less than 95.03 per cent at quarter load. In the case of a 50-kw transformer these figures attain 98.05 and 96.85 per cent, respectively. In each of the above cases the frequency is 60 cycles.

Fig. 6 gives a full load temperature test of a 5-kw, 60-cycle transformer. It will be noted that these curves extend over 15 hours of test instead of 8 hours, as has been the general custom. As the curves show that the temperature for an 8-hours' run is considerably below the maximum temperature attained, the advisability of using the longer period in transformer tests is obvious.

In Fig. 1 the shell of an O. D. transformer is shown, and in Fig. 2 the transformer is represented ready for casing. Fig. 3 shows a transformer being lifted out of its case. The use of oil in this type of transformer is recommended, though not obligatory.

Electrically Driven Boring Machine.

The accompanying illustration shows a boring machine, which is driven by an Onondaga motor geared thereto. The standards, or feet of this motor, are cast solid into the magnet frame, providing for adjustment to the base frame of the boring machine, as shown. These motors are applicable to other machine tools, such as lathes, drill presses, bending rolls, pumps, blowers, etc., and also to printing presses. They are intended for use only in cases where very slow



BORING MACHINE DRIVEN BY ELECTRIC MOTOR.

speed is required. The bearings are supported from the center of the magnet frame by cast iron brackets bolted to the frame.

The cast iron magnet yoke is split horizontally to facilitate assembling. The armature of these motors is of the barrel type, and is well ventilated by means of openings from the inside of the spider, which allow the air to pass out through the core and circulate about the windings.

These motors, which are manufactured by the Onondaga Dynamo Company, Syracuse, N. Y., are made in sizes ranging from 1 to 10 hp, and designed for use on direct-current circuits of 110, 220 and 500 volts.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Money on call closed nominally at 6 per cent; time money was inactive, due chiefly to the fact that borrowers are disposed to defer making time contracts, awaiting lower rates. The closing rates are 5 per cent for 30 to 60 days, 5@5½ per cent for three, four, five and six months. In the stock market there was a stronger tone as the result of large investment demands and renewed speculative buying. In the face of very firm money rates speculative interests seem inclined to discount the probability of easier conditions as to loans and the continuance of investment buying. Public participation in the market increased considerably. In the traction list Brooklyn Rapid Transit stock was a feature on Friday, and made a sudden manipulative advance, the closing price being 66⅞, a net gain of 1⅝ points. The range of prices during the week was from 65⅝ to 68⅜, the number of shares sold being 57,710. Metropolitan Street Railway closed at 163, being a net gain of ¾ point, the sales aggregating 16,100 shares. Manhattan Elevated lost ⅞ of a point on the week's trading of 58,950 shares, closing at 137. General Electric closed at 280, ex-dividend, which is a net loss of 1 point as compared with the closing price of the previous week. Westinghouse Electric, common, made a net gain of 2 points, closing at 179, but first preferred lost 5 points, closing at 182. Western Union closed at 92⅜, being a net gain of ⅝ point, the sales aggregating 17,325. Closing quotations of other electrical securities are: American District Telegraph, 38, a net gain of 1¾ points, and Commercial Cable, 160, a net loss of 10 points. Following are the closing quotations of Jan. 7:

NEW YORK.

	Dec. 30.	Jan. 7.		Dec. 30.	Jan. 7.
American Tel. & Cable..	96*	90	General Electric.....	283¾	279
American Dist. Tel.....	36	—	General Carriage.....	1⅜	1¼
Brooklyn Rapid Transit..	64⅝	65⅞	Hudson River Tel.....	104	100
Ches. & Pot. Telephone..	65	—	Metropolitan Street Ry...	161	162¾
Commercial Cable.....	170	155	N. E. Elec. Veh. Tran...	—	½
Electric Boat.....	19½	24½	N. Y. Elec. Veh. Tran..	12	12
Electric Boat pfd.....	40	45	N. Y. & N. J. Tel.....	167	—
Electric Lead Reduc'n...	1½	1¾	Tel. & Tel. Co. of Am...	—	—
Electric Vehicle.....	2¼	2	Western Union Tel.....	92⅜	91
Electric Vehicle pfd.....	4	4	West. E. & M. Co.....	177	177
			West. E. & M. Co., pfd..	182	—

BOSTON.

	Dec. 30.	Jan. 7.		Dec. 30.	Jan. 7.
Am. Tel & Tel.....	164½	161	Mexican Telephone.....	2	2
Cumberland Telephone...	—	—	New England Telephone.	133	137
Edison Elec. Illum.....	242	—	Westinghouse Elec.....	85	90
Erie Telephone.....	15½	15⅝	Westinghouse Elec. pfd..	90	89¾
General Electric pfd....	—	—			

PHILADELPHIA.

	Dec. 30.	Jan. 7.		Dec. 30.	Jan. 7.
American Railways.....	44½	44¾	Phila. Traction.....	97¾	97¾
Electric Storage Battery.	62	62	Philadelphia Electric....	4¾	4½
Elec. Storage Batt'y pfd.	62	—	Pa. Electric Vehicle.....	¾	—
Elec. Co. of America....	6⅛	6¼	Pa. Elec. Veh. pfd.....	2	2½

CHICAGO.

	Dec. 30.	Jan. 7.		Dec. 30.	Jan. 7.
Central Union Telephone.	—	—	National Carbon pfd.....	82½	84
Chicago Edison.....	160	—	Northwest Elev. com....	39	39¾
Chicago City Ry.....	185	188	Union Traction.....	10⅝	10½
Chicago Telep. Co.....	225*	230	Union Traction pfd.....	47	—
National Carbon.....	19	19			

*Asked.

NEW YORK DISTRICT TELEGRAPH is the storm center of a big row, and a movement has been launched against the present management by a number of stockholders who have issued a circular against President T. T. Eckert and his following. As might have been expected, the doughty general joins issue. His circular requests the stockholders to give an expression of opinion on a plan to decrease the capital stock of the company from $4,000,000 to $2,000,000. A resolution to this effect will be introduced at the annual meeting on Jan. 23, if, in the judgment of the directors, the stockholders are willing that this shall be done. No reasons are given for cutting the capital of the company in two. The point is made, however, that during the last nine years, from 1892 to 1900, inclusive, dividends amounting to 19½ per cent have been declared upon a capital of $4,000,000, or on an average of 2 1-6 per cent a year, which would have been 4⅓ per cent on a capital of $2,000,000. The company has about 30,000 messenger call boxes in the city, and works closely with the Western Union. The business has undoubtedly suffered sharply from the growth of the telephone, and the trouble appears to lie in the proposal to adjust the capital to newer conditions.

CLEVELAND FEDERAL TELEPHONE.—There has been a severe decline at Cleveland in the shares of the Federal Telephone Company, independent, which has been backed by the Everett-Moore Syndicate. The shares have declined from $25 to $5. The Federal Company is a parent company controlling 20 sub-companies and 36 exchanges. Its principal exchanges are in Cleveland and Detroit, where it has been in competition with Erie companies. It has been expanding rapidly, and is now engaged in building exchanges in Toledo, Dayton and Springfield, Ohio, and extending into Michigan. Among the telephone properties owned outright or controlled by the syndicate are the Cuyahoga Telephone Company, of Cleveland, with upward of 10,000 subscribers; the United States Telephone Company, the Federal Telephone Company, the Stark County Telephone Company, the Columbian County Telephone Company,, the People's Telephone Company, of Detroit; the Wood County Telephone Company, and several others in which the Federal Telephone Company is the controlling factor.

BELL TELEPHONE.—The American Telephone & Telegraph instrument statement for the month ended Dec. 20 shows:

	1901.	1900.	Changes.
Gross output	92,732	63,196	Inc. 29,536
Returned	34,688	23,593	Inc. 11,095
Net output	58,044	39,603	Inc. 18,441
Since Dec. 20, 1900:			
Gross output	960,055	683,955	Inc. 276,100
Returned	386,861	372,311	Inc. 14,550
Net output	573,194	372,311	Inc. 200,883
Total outstanding ...	2,526,010	1,952,816	Inc. 573,194

This should mean about 1,100,000 subscribers, or about 200,000 to 250,000 in the last year. No great hurt is shown from the independent movement.

CONSOLIDATED EXCHANGE TELEGRAPHS.—A meeting of the board of directors of the New York Consolidated Stock Exchange last week was held to consider a proposition to establish a special wire system for the Exchange to Western cities. This is for the purpose of securing a large part of the trade that at present is going to bucket shops. President Wagar said that the plan was enthusiastically approved of. The work of constructing this system will now be placed in the hands of a special committee. When the intention of the Exchange to inaugurate a service of this kind was made known, $1,000 was bid for a seat on the Exchange. The only seat offered was held at $1,100.

EVERETT-MOORE TROLLEYS.—A special telegram of Jan. 4 from Cleveland, Ohio, says: After a busy session lasting from early this morning until 9 o'clock to-night, the Cleveland Bankers' Committee in charge of the Everett-Moore Syndicate's affairs announced that there would be a surplus of about $3,000,000 over all liabilities, providing the committee succeeds in bringing about a general extension of credit. More than 50 per cent of the liabilities were represented by the creditors the committee talked with, and not a single refusal had been received when the committee asked for an extension of time of 18 months.

TROLLEY PARALLEL DIVIDENDS.—A telegram from Hartford, Conn., of Jan. 2 says: The declaration of a semi-annual dividend of 3 per cent by the electric street railway between Norwich and New London is of interest as illustrating the profitableness and effectiveness of the trolley's competition with a steam line. This interurban trolley parallels the Central Vermont Railroad, and when it was built many observers predicted that the venture would not be financially profitable. The trolley has not only diverted a large amount of patronage from the steam road, but it has also developed a considerable volume of traffic that was previously dormant.

DETROIT & TOLEDO SHORE.—The Ohio Savings Bank and D. B. Cunningham, Toledo, Ohio, have been appointed receivers for the Detroit & Toledo Shore Railroad. The Strange Contracting Company is the complainant with a claim of $158,000. This is an Everett-Moore electric line, and the action is due to the troubles of the syndicate.

WESTINGHOUSE MACHINE COMPANY.—The capital of the Westinghouse Machine Company has been increased from $3,000,000 to $5,000,000. The preferred rights will be relinquished and all stock will be the same. The company earned 20 per cent net for the year.

CONNECTICUT RAILWAY & LIGHTING.—There have been listed in Philadelphia $8,355,000 first and refunding 4½s gold bonds of the Connecticut Railway & Lighting Company, due 1951, also

$2,500,000 first mortgage 5s gold bonds of Syracuse Rapid Transit Railway due 1946.

SAVANNAH ELECTRIC COMPANY.—With regard to the electric light deal at Savannah, Ga., it is now announced that Lee, Higginson & Co. and Stone & Webster, of Boston, have organized the Savannah Electric Company, with $2,500,000 5-per-cent 50-year bonds, $1,000,000 6 per cent preferred stock and $2,500,000 common stock, to take over the entire street railway and lighting system of Savannah, Ga., which have perpetual franchises. The companies taken over comprise the Edison Electric Illuminating Company, which has an extensive underground system of distribution and has been paying regular dividends at the rate of 6 per cent; the City & Suburban Railway Company and the Savannah & Thunderbolt Line, which traction companies control the street railway facilities of the city. Of the $2,500,000 5 per cent bonds $1,000,000 will be reserved to retire $1,000,000 4 per cent bonds of the Savannah & Thunderbolt Company. The bond mortgage contains a provision allowing the further issue of $1,000,000 bonds for new equipment and construction. The entire bond issue is subject to call at 110. The railway system of Savannah comprises about 54 miles of track and the present plant, with some suburban extensions, should meet the needs of the city for some years to come. Messrs. Stone & Webster have managed the lighting company since Jan. 1, 1899, and will be continued as managers of the combined properties. Earnings are sufficient to make sure the 6 per cent dividends on the preferred stock. The securities will be listed on the Boston Stock Exchange, as Boston capital is largely interested in the enterprise.

PORTO RICO ELECTRICS.—The Ponce Electric Company and the Ponce Railway & Electric Light Company, capitalized at $415,000 and $50,000, respectively, have been incorporated in Trenton to do business in Porto Rico.

DIVIDENDS.—The regular quarterly dividend of 1¼ per cent has been declared upon the preferred stock of the Bullock Electric Manufacturing Company, payable Jan. 2.

Commercial Intelligence.

THE WEEK IN TRADE.—Industrial, commercial and financial conditions are in every respect satisfactory, although during the past week there was some dullness as regards new business, due, to some extent, to stock-taking and preparing for the future. A conspicuous exception to the general quietness was the iron and steel situation, which was more active. The car shortage is still a disturbing element in the situation, and continues to unsettle both production and consumption considerably. The only appearance of weakness in finished products is in wire and nails, which are $2 per ton lower, owing to increased competition. Heavy rail orders for Mexico are reported pending. An international competition promises to be begun in this respect. Floods in the mining regions have interfered with production, and the car shortage still accentuates the scarcity of coal, particularly bituminous. Anthracite supplies are smaller, notwithstanding the total production last year in excess of 53,000,000 tons, a total 12 per cent larger than ever before produced. On Friday the United Metals Selling Company, the selling agent for the Amalgamated Copper Company, announced a further cut—the fourth—in the price of copper of ⅞ cent a pound for Lake. This brings the price of Lake practically 5 cents a pound under the 17-cent price at which the Amalgamated interests originally attempted to hold the metal. The quotations are now 12⅛ cents for Lake, 12 cents for electrolytic and 11½ cents for casting. Still lower prices are looked for. It is stated that the last cut was forced by recent reductions in the prices of all grades made by independent producers. Brass has been lowered to meet the decline in copper as presaged in last issue. The business failures for the week, as reported by *Bradstreet's*, number 270, as against 219 the week previous and 268 the corresponding week last year. *Bradstreet's* points out that the business failures were unusually small after the holidays, and failures were fewer in December than in the same month of the preceding year. For the year they number 10,657, with liabilities of $129,978,838, an increase of 7.5 per cent over 1900 as to number, and of 2.4 per cent as to liabilities. The percentage of assets to liabilities was only 46.9, the smallest proportion reported since 1885.

ARGENTINE REPUBLIC TRADE.—Electrical machinery from the United States has a constantly augmenting representation in the Argentine Republic. Wherever the electrical manufacturers of the United States have (as has been the case in the Argentine Republic) introducd their wares by means of intelligent, well-informed and persistent resident agents, speaking the language and acquainted with the customs of the people, they have been successful in building up a large and growing demand for supplies. The increase in the value of electric and scientific apparatus taken by the Argentine Republic from the United States is shown by the following statistics: Fiscal year 1899, $247,062; 1900, $259,608; 1901, $307,490. The connection between the national telegraph systems of Uruguay and the Argentine Republic has been completed by a cable crossing the Uruguay River, uniting Santa Rosa and Monte Caseos. The other three points of connection are at Martin Chico, on a direct line from Montevideo and Buenos Ayres, Salto to Concordia, and from the Uruguayan frontier at Paysandu to Concepcion. The latest connection, besides completing the unity of the two systems, will be of great importance in communication from both Republics to the Republic of Brazil. Before long the telegraph systems of all three of these South American countries will be united.

AUTOMOBILE TRADE SHOW FOR WASHINGTON.—On Friday evening, Jan. 3, 1902, a meeting of the local dealers in automobiles was held at Barton's Hotel, Washington, and resulted in forming the Washington Automobile Dealers' Association. The following were elected officers for the ensuing year: Frank Boyd, president; Schuyler S. Old, Jr., secretary; W. J. Foss, treasurer. The above-named constitute the executive committee. It was decided at this meeting to hold an automobile show in Washington during March, 1902, each dealer pledging to take space, and to contribute to the general expenses of holding a show. A number of prominent manufacturers of automobiles and automobile accessories have also pledged their support, so that the show will be held in spite of failure to secure the sanction of the National Automobile Manufacturers' Association. The show will be held in the large armory of the Washington Light Infantry Corps. The automobile dealers are doing a good business, and feel the money spent on a show will be the best form of local advertising they can do. Mr. B. C. Washington, Jr., has been elected as general manager by the Dealers' Association.

CRUDE RUBBER FAILURE.—The electrical trade generally is very much interested in the failure of the Crude Rubber Company to meet its obligations, as it seems to involve much cheaper rubber for insulation purposes, etc. The failure has naturally unsettled the market, as with between $2,000,000 and $3,000,000 worth of rubber in the hands of the bankers it is somewhat difficult to say at what price it will be sold. Since the failure of the Crude Rubber Company the price of Up-River Para has declined 2 cents per pound to 82 cents. It is trade rumor that the United States Rubber Company in purchasing $1,000,000 worth of crude from the Crude Rubber Company, paid 81 cents per pound for Up-River Para and 77½ cents for Island rubber, but this rumor lacks confirmation. It is thought not unlikely, however, that the elimination of the Crude Rubber Company from the field, with its stock of high-priced rubber, will be taken advantage of to form a crude rubber combination, as great economies could be introduced through such a combination and the importers and consumers of rubber alike benefited.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY has added four new and important foreign agencies. Wm. M. McLean & Co., of Melbourne, Australia, will have direct supervision over Australia, New Zealand, Tasmania and Fiji. Arrangements have been perfected with the Bullock Company by Mr. O. L. Remington, of the firm, who has been visiting headquarters in Norwood. J. H. Newby, of the Bullock works, will also be identified with the Melbourne office. The new agency for Manchuria and Eastern Siberia will be in charge of E. L. Richardson & Co. Mr. Richardson will ultimately make his headquarters in New York. He will travel extensively in Russia for a few months. The new Japanese agency is at Tokio, and H. S. Tanaka & Co. will be in charge. The new agency for Porto Rico is at San Jose, with T. S. Allen in charge. Mr. F. G. Bolles, who has been in charge of the publicity department of the Bullock Company's business for several years, was promoted on the first of the year to be manager of foreign agencies.

PROMINENT LONDON ENGINEER HERE.—Mr. Charles S. Drummond, who is one of the active directors of the British Electric Traction Company, Limited, of London, which concern is the largest company of its kind in the United Kingdom, is now in this city. Mr. Drummond devotes his attention principally to the management of the various traction enterprises in which the British Company is interested. He may be found at the offices in the Broad Exchange Building, 25 Broad Street, of Frederic B. Esler.

VENTILATING FAN MOTORS.—Sealed proposals will be received by the United States Engineer Office, Washington, until noon, Feb. 3, 1902, and then publicly opened for furnishing ventilating fans, with direct connected motors for the new building for the Government Printing Office. Information will be furnished on application by Captain John Stephen Sewell, of the United States Engineer Corps.

ELECTRIC LIGHTING IN SUEZ.—Tenders are called for until Jan. 15 for the installation of an electric lighting system in Suez and Damanhour, including the overhead wires for distribution. Specifications for the work may be obtained of the Minister of Public Works, Cairo, Egypt.

EXPORTS OF ELECTRICAL MATERIAL AND MACHINERY.—The following are the exports of electrical material, machinery, etc., from the port of New York for the week ended Dec. 31: Antwerp—2 pkgs. machinery, $317; 8 pkgs. material, $335. Bristol—8 pkgs. machinery, $480; 40 pkgs. wire, $610; 62 pkgs. copper material, $3,500. Berlin—1 pkg. material, $100. British Australia—96 pkgs. wire, $2,287; 22 pkgs. material, $1,654; 259 pkgs. machinery, $20,864. British Possessions in Africa—5 pkgs. material, $466. British Possessions (all others)—1 pkg. machinery, $35. Bolton—4 pkgs. wire, $275. Brazil—76 pkgs. material, $3,207. British East Indies—302 pkgs. material, $5,680; 8 pkgs. machinery, $1,800. British Guiana—26 pkgs. material, $400. British West Indies—24 pkgs. material, $566; 2 pkgs. wire, $59. Central America—15 pkgs. material, $193; 2 pkgs. copper wire, $93. Cuba—154 pkgs. material, $1,758; 18 pkgs. wire, $64. Chili—74 pkgs. material, $3,260. Glasgow—12 pkgs. machinery, $1,025. Genoa—1 pkg. material, $113. Hamburg—14 pkgs. material, $2,222. Havre—13 pkgs. material, $983; 18 pkgs. machinery, $4,668. Leicester—3 pkgs. wire, $322. Leeds—15 pkgs. material, $261. Liverpool—86 pkgs. machinery, $6,761; 43 pkgs. material, $2,605; 674,123 lbs. copper, $113,095; 890 pkgs. material, $79,500; 120 pkgs. wire, $2,730; 6 pkgs. motors, $1,173. London—173 pkgs. machinery, $7,317; 163 pkgs. material, $8,857. Manchester—179 pkgs. machinery, $38,533; 3 pkgs. wire, $15. Mexico—127 pkgs. material, $3,497; 41 pkgs. machinery, $5,040. Marseilles—1 pkg. material, $75. Milan—3 pkgs. material, $60. Nice—2 pkgs. machinery, $500. Newcastle—14 pkgs. machinery, $2,297. Oporto—2 pkgs. material, $200. Peru—8 pkgs. material, $338. Rotterdam—8 pkgs. material, $131. Santo Domingo—4 pkgs. material, $124. Southampton—19 pkgs. material, $1,236; 10 pkgs. wire, $735. Sunderland—1 pkg. material, $16. U. S. Colombia—2 pkgs. machinery, $100.

HARRISBURG ENGINE SALES.—Mr. W. P. Mackenzie, 203 Broadway, New York, reports that the Harrisburg Engine domestic contracts recently secured through its local offices include one for high-speed engines, intended to displace others for lighting purposes, at the Hotel Netherland, New York City. The order calls for a 300-hp simple Harrisburg standard engine, also a 225-hp machine of the same type. These engines are to be direct connected to generators of 200 kw and 150 kw capacity, built by the Western Electric Company. Two 150-hp compound engines have been ordered by the Pennsylvania Steel Company for the equipment of its Steelton (Pa.) plant. The generators therewith are to be built by the Eddy Manufacturing Company. These machines will be 100 kw each. The Farrell Foundry & Machine Company, of Ansonia, Conn., has ordered a 220-hp tandem compound standard engine for direct connection to a 150-kw General Electric generator. This equipment will be used to run cranes. The Ashley & Bailey Mills, Paterson, N. J., are to be installed with a 75-hp simple engine, direct connected to a 50-hp generator manufactured by the New England Electric Company, of Lowell, Mass. The Northport (L. I.) Electric Light Company has requisitioned for a 100-hp, also a 60-hp Harrisburg standard-belted engine for street railway work. Contracts recently secured through the Philadelphia offices of the Harrisburg Company include one for two tandem compound four-valve engines, of 600 hp each, for Reading (Pa.) street railway work, and a machine of similar description for the Wilmington (Del.) electric traction plant.

VILTER ORDERS FOR ENGINES.—The Vilter Manufacturing Company, among their recent orders, including a large variety of refrigerating plants, etc., report also the following sales of Corliss engines: Goetz & Brada Manufacturing Company, Chicago, Ill., 12 by 30; Sawyer & Austin Lumber Company, Pine Bluff, Ark., 24 by 42; Duluth Brewing & Malting Company, Duluth, Minn., 16 by 36; Allentown Shoe Manufacturing Company, Allentown, Pa., 12 by 30; Ambrose West, Plymouth, Pa., 14 by 36; Deerbrook Milling & Mercantile Company, Deerbrook, Wis., 12 by 30; South Bend Chilled Plow Company, South Bend, Ind., 24 by 42; Wendnagel & Co., Chicago, Ill., 16 by 36; Schiess y Cia., Torreon, Mex., 14 by 36; Hess & Hopkins Leather Company, Rockford, Ill., 18 by 42; Binsfeld Brothers, Chilton, Wis., 14 by 30; O. F. Mayer & Brothers, Chicago, Ill., 12 by 30; Foster-Hafner Mills, Oshkosh, Wis., 24 by 48; Bloch Brothers Tobacco Company, Wheeling, W. Va., 18 by 36; T. G. Mandt Vehicle Company, Stoughton, Wis., 18 by 36; American Hulled Bean Company, Battle Creek, Mich., 14 by 36; Moore-Cortes Canal Company, Crowley, La., 22 by 44 by 48 tandem compound Corliss engine; Roller Canal Company, Crowley, La., 26 by 48 Corliss engine.

AN ELECTRICALLY EQUIPPED BREWERY FOR SOUTH AFRICA.—An American electrically equipped brewery is now under construction at Cape Town, South Africa, which will be the first electrical plant of its description on that continent. The brewery is being erected from plans executed by H. Steinmann, the brewery architect, of 66-68 New Street, New York City, and will be operated by the South African Breweries, Limited, a syndicate composed of some of the leading brewers in Great Britain. Everything, otherwise than the bricks and mortar, will be manufactured in the United States. The total cost of the establishment will be about $550,000, the equipment alone causing the expenditure of over a quarter of a million dollars. The plant is to have an annual capacity for turning out 120,000 barrels of ale, 60,000 barrels of lager and 40,000 barrels of porter and stout. The electrical apparatus, etc., will consist of two 75-kw General Electric generators, direct connected to horizontal compound engines, to be supplied by the Payne Engineering Company. There are also to be one 35-hp, one 25-hp, four 15-hp, two 7½-hp and one 5-hp motors. The brewery is expected to begin active operations by May 1.

TELEGRAPH, TELEPHONE & CABLE COMPANY.—Advices from Cleveland state that Judge Thomas is there working on a plan to take the Federal & United States Telephone properties off the hands of the Everett-Moore bankers and consolidate with the Telephone, Telegraph & Cable Company of America. It is alleged in New York and Boston financial organs that the difficulties met by the Everett-Moore Syndicate in raising further money were due to opposition stirred up by Bell telephone interests, who tried to buy their independent telephone properties at the panic prices so as to turn them over to the Central Union system, and that it was in this way rather than by opposition due to steam railroad financiers that the troubles really arose; in fact, large amounts of the telephone stock are said to have been bought up with Bell capital, but these later dispatches would leave it to be inferred that the properties have not yet been "gathered in." If they were, it might make considerable difference to the independent telephone cause. Hence the interest attaching to these rumors about Judge Thomas and the T., T. & C. plans.

THE PENN MANUFACTURING SUPPLY COMPANY, of Philadelphia, which has been doing business as a partnership, has recently incorporated with $100,000 paid in capital. This concern is likely to play a prominent part in the electrical field as manufacturers' agents, because of the extensive connections which it has with the buyer and the seller in the larger realm of electrical supplies and novelties. The multiplicity of electrical specialties, which are being put on the market to-day, and the increasingly large expense for marketing the same, opens up a productive field for the manufacturer's agent. The Penn Manufacturing Supply Company has opened attractive offices in the Forest Building in Philadelphia, and is looking forward a little later in the year to establishing offices in New York, Boston, Pittsburg and Chicago, and has our best wishes for its success.

LOWER COPPER.—One more cut in the price of Lake copper was announced last week—seven-eighths of a cent per pound—making the price 12⅛ cents per pound, or nearly 5 cents less than the early December prices. It was also announced that a reduction of seven-eighths of a cent had been made in electrolytic copper, making the price 12 cents; and in castings a 1-cent reduction to 11½ cents. There have been three previous reductions in the price of copper. The first, on Dec. 13, was from 17 to 15½ cents; the second, on Dec. 18, from 15½ to 14 cents; the third, on Dec. 19, from 14 to 13 cents. It would seem that the latest quotations must be bed rock—possibly intended to shake out cheap independent producers.

FOREIGN CONTRACTS PENDING FOR CONDUIT.—The American Vitrified Conduit Company, whose offices are in the Taylor Building, 39-41 Cortlandt Street, is anticipating the receipt, within the next week or two, of a substantial Russian contract for conduit. The material is intended to be utilized in connection with electric lighting, etc. Quotations have been asked on some 3,500,000 ft. of conduit, which will represent the expenditure of some $250,000. The company is also said to be bidding on a large Belgian contract. In this instance the conduit is required for telephone wires.

PHILIPPINES CABLE.—The United States Government is about to let a contract for the furnishing of some 250 miles of single conductor telegraph cable, which is to be used for military purposes in the Philippines.

SUMPTER DEVELOPMENT COMPANY, of Sumpter, Ore., who own the Sumpter Light & Power Company, are building an electric road, and have been in the market for direct-current generator, engine and boiler plant, etc.

THE GRANBY RUBBER COMPANY, Granby, Que., will build an industrial railway system in connection with its works, for which plans are now being prepared. The railway will be narrow gauge and motive power electricity.

CATALOGUES WANTED.—The Patterson Tool & Supply Company, Dayton, Ohio, is opening an electrical supply branch in connection with its business, and solicits catalogues and prices from manufacturers of electrical goods.

BRASS PRICES.—The Brass Association announces the following cuts: Wire and rods from 30 to 37½ per cent, brass tubing from 40 to 45 per cent. Like the cut in sheets, to 18 cents, these reductions put the product on a price equality with copper at 13 cents.

EXCELSIOR IRON WORKS, Cleveland, Ohio, are reported in the market for various electrical equipment.

General News.

THE TELEPHONE.

SADORUS, ILL.—It is reported that Sadorus is to have a new telephone line for the benefit of the grain merchants.

ELGIN, ILL.—The Northwestern Telephone stockholders held a meeting at Aurora and voted to consolidate with the Interstate Telephone Company.

MORRISON, ILL.—The Central Union Telephone Company is building a line from Garden Plain to Albany. The line will be continued on to Cordova in the spring.

GREENFIELD, IND.—The Extra Telephone Company, capital stock $160, has been incorporated. Directors: J. C. Catt, A. L. Zimmerman, G. E. Lacy, N. S. Catt, Lena Walker, C. A. Jackson and R. S. McClannon.

HENRYVILLE, IND.—The Cumberland Telephone Company has announced that its telephone exchange in this place will be ready for business Feb. 1. The exchange will include Memphis and Ostisco subscribers. This will make three telephone companies in this city.

TERRE HAUTE, IND.—The farmer lines of telephones are playing an important part in the enforcement of the game law. A woman owning a farm in this county telephoned the game warden that hunters were on her farm without permission. The warden arrived on her farm in time to arrest the four hunters, who had no idea an officer could be summoned without their being aware of the fact by seeing the messenger start to town. Each offender was fined.

INDIANAPOLIS, IND.—The Board of Public Safety has awarded a contract to the Central Union Telephone Company to furnish the fire department with three business independent line connections, four business independent line connections for the police department and seven resident independent connections. The consideration is $490. The "big end" of the telephone contract—$1,310—went to the New Company, and it is thought the board let the contract to the Central Union to "even up."

INDIANAPOLIS, IND.—The following telephone companies have filed articles of incorporation: The College Corner & Southern Telephone Company, to operate a telephone system in Union and Franklin counties; directors, Charles Stout, J. C. Barkley, James James, L. B. Barkley and W. E. Bake. The New Ross Co-operative Telephone Company, of New Ross, Ind.; directors, C. E. Johnson, F. J. Brooker, R. F. King, R. L. Brattan and D. W. Lane. The Branch Independent Telephone Company, of Saratoga; capital, $10,000; directors, P. A. Dailey, Cyrus Bousman, Eliza Dailey, M. Y. Bousman and Charles Skinner.

INDIANAPOLIS, IND.—The New Telephone Company was the successful bidder and will furnish telephone service to the various city departments. The contract calls for two trunk lines from the exchange to the police headquarters and three trunk lines to fire headquarters. The contract for furnishing receivers and transmitters for the Gamewell police and fire alarm boxes at the rental rate of $150 per year for 105 boxes and transmitters and receivers was also awarded to the New Company. The city also agreed to purchase for the city the receivers and transmitters for $400, and if the purchase is made within six months the sum to be paid for rental will be applied on the purchase price. Free telephones and service will be given to the homes of the members of the Board of Public Safety, the clerk of the board and other officers of the department.

WASHINGTON, IA.—A new telephone line is to be built from Bishop, near Lexington to Wellman. A line to Washington from the same starting point is talked of.

ATCHISON, KAN.—Edward Foote, of Clyde, is trying to secure a franchise to build a telephone exchange in Effingham.

PADUCAH, KY.—A new telephone line is to be built from Paducah, Ky., to Joppa, Ill.

MAYSVILLE, KY.—The farmers of Mason County are organizing a Home Telephone Company. The leaders of the enterprise are William Luttrell, Abner Hord, John T. Martin, W. L. Holton, W. H. Robb, William McLlelland and others.

MOREAUVILLE, LA.—The Avoyelles Telephone Company, of which Mr. A. O. Boyer, of this town, is president, has completed its line from Bunkle to this place. The company will have in the near future lines from this town to Bordelonville, Plancheville, Mansura and Marksville.

PORTLAND, ME.—The Dirigo Telephone Company has been granted permission to construct conduits and run its wires through them in many streets in this city.

ONTONAGON, MICH.—The Ontonagon Telephone Company, capital stock $25,000, has been incorporated.

MARQUETTE, MICH.—A company has been organized to construct a telephone line between Ironwood and other cities on the Gogebic range and those at the head of the lake.

MARSHALL, MICH.—In compliance with the resolutions adopted at a citizens' meeting some time ago about 100 Michigan Telephone Company residence telephones were ordered taken out on Jan. 1, as the subscribers refused to agree to the raise in rates. Two other telephone companies are seeking franchises.

VIRGINIA CITY, MINN.—People's Telephone & Telegraph Company, capital stock $50,000, has been incorporated by P. E. Bailey and A. C. Orborn, Evelett; and P. A. Coffey, D. W. Freeman and R. B. Greedy, Virginia City, Minn.

WINONA, MINN.—The Greenwood Telephone Company has been formed at Plainview with an authorized capital stock of $25,000. Plainview, Weaver, Thellman, Kegan and Beave will be connected. The incorporators are Andrew French, Wm. Lea, F. D. Washburn, Lawrence Ryan, F. H. Hanneman, Frank Appel and Hey Grove.

HAVRE, MONT.—The Town Council has decided to grant the electric light, waterworks, steam heat and telephone franchises petitioned for by E. V. Hauser.

HELENA, MONT.—Articles of incorporation have been filed by the Montana & Wyoming Telephone Company, with a capital stock of $40,000. The purpose of the company is to connect Montana and Wyoming points by telephone. The present termini of the company's lines are Billings, Mont., and Basin, Wyo. The principal places of business of the company are designated as Red Lodge and Billings. Incorporators: L. L. Moffett, Billings; C. C. Bowlen, Red Lodge; P. B. Moss, Billings; J. F. Trumbo, Bridge; B. E. Vaill, Carbondale; Charles M. Blair, Billings; R. L. Davis, W. A. Talmage, J. S. Robbins, Red Lodge.

KANSAS CITY, MO.—The People's Telephone Company, capital stock $50,000, has been incorporated by Henry Wood, W. H. Steele and others.

JEFFERSON CITY, MO.—The De Kalb County Mutual Telephone Company has filed a statement of increase of capital stock from $5,000 to $25,000.

MEMPHIS, MO.—The telephone system here has passed into the hands of a new company composed of John M. Janes, W. L. Scott, David Secor, J. J. Risk, G. E. Leslie, W. W. Eckman and J. J. Townsend.

HASTINGS, NEB.—The American District Telegraph Company has asked the City Council of Hastings for a franchise.

AURORA, NEB.—The Nebraska Telephone Company is at work on a plan to consolidate Aurora, Hampton, Marquette, Giltner and Phillips into one exchange with the central station in Aurora.

MANCHESTER, N. H.—At the annual meeting of the Northern Telegraph Company the following officers were re-elected: President, Marion C. Smyth; clerk, Arthur H. Hale; directors, Marion C. Smyth, Arthur E. Clarke, Charles H. Anderson. The treasurer, A. F. Emerson, holds over. A dividend of two and one-half per cent. was declared.

ROCHESTER, N. Y.—The Rochester Telephone Company, of Rochester, has filed a certificate of increase of capital from $400,000 to $700,000.

MINGOE JUNCTION, OHIO.—The Bell Telephone Company has opened a new exchange here.

NORWALK, OHIO.—The Bankers' Telephone Company, capital stock $10,000, has been incorporated.

ZANESVILLE, OHIO.—The board of education has called for bids for telephones in all school buildings.

CALCUTTA, OHIO.—The Columbiana County Telephone Company is planning to establish an exchange in this place with toll lines to East Liverpool.

URBANA, OHIO.—C. H. Marvin, of this city, has filed a petition asking for the appointment of a receiver for the Mechanicsburg Telephone Company.

ORRVILLE, OHIO.—The Central Union Telephone Company has filed a petition in the Probate Court to have the mode of construction for its lines determined.

EAST LIVERPOOL, OHIO.—Operators at the Columbiana County Telephone Company's exchange went on strike a few days ago, but the difficulty was soon adjusted.

LIMA, OHIO.—The Lima Telephone & Telegraph Company has cut in its new exchange, which has just been completed. The company is securing many new subscribers.

GENEVA, OHIO.—The Madison Telephone Company is building several farmers' lines in the vicinity of this town, and is preparing to place metallic circuits on all lines.

CADIZ, OHIO.—The Harrison County Telephone Company has just installed an addition to its switchboard, the increase being necessary to take care of a large number of new suscribers.

ALLIANCE, OHIO.—The exchange of the Stark County Telephone Company at Alliance is now in full operation, with 400 subscribers connected up. The list is increasing every day.

COLUMBUS, OHIO.—The Central Union Telephone Company has appointed a subscribers' agent whose duty it will be to inspect telephone instruments and receive suggestions from subscribers.

ORWELL, OHIO.—The directors of the Madison Telephone Company have declared a 3 per cent. dividend, payable Jan. 20. The company will make a number of improvements to its system.

HAMILTON, OHIO.—The City & Suburban Telegraph Association of Cincinnati, has been granted a franchise by the Butler County Commissioners to build a number of pole lines in the county.

UPPER SANDUSKY, OHIO.—The Upper Sandusky Home Telephone Company is making rapid gains among the farmers in this vicinity. Over twenty-five subscribers were secured in the rural district within ten days recently.

YELLOW SPRINGS, OHIO.—It is reported that the two separate telephone systems now being established in Clarke and Greene counties, will ultimately be merged under one management, to be known as the Home Telephone Company.

MECHANICSBURG, OHIO.—C. H. Marvin, a former director of the Mechanicsburg Telephone Company, has asked that a receiver be appointed for the company in order to protect him on certain notes which he signed as surety while he was a director.

CONNEAUT, OHIO.—The new exchange of the Conneaut Telephone Company will be placed in operation in about two weeks. Cables have been laid for 1500 lines and the switchboard has a capacity of 700. A number of lines have already been connected.

PORTSMOUTH, OHIO.—During November, the Portsmouth Telephone Company made a net gain of nearly 100 subscribers, which will necessitate the installation of another switchboard and additional cable. The telephone business along the Ohio River is growing rapidly.

CHILLICOTHE, OHIO.—Because of an advance in rates by the Bell Company the physicians of Chillicothe have signed an agreement dispensing with the use of Bell telephones after Jan. 1. The Ross County Telephone Company made a proposition which was accepted by all the physicians.

TOLEDO, OHIO.—The Toledo Home Telephone Company has opened an exchange at Whitehouse with sixty subscribers, and another at Maumee with about

the same number. The new exchange at Sylvania will be opened within a few days. Work on the main Toledo exchange is progressing rapidly.

ST. CLAIRESVILLE, OHIO.—The Belmont Telephone Company has completed its line to West Wheeling. At this point it was expected that the line would connect with the independent company at Bellaire, but there has been a hitch, and it is stated that the Belmont Company may build a line of its own through Bellaire.

OKLAHOMA CITY, OKLA.—The Oklahoma Consolidated Railway Company will operate a telephone system in connection with its electric railways.

PHILADELPHIA, PA.—A local telephone line will connect the villages of Worcester, Centre Square, West Point, Lansdale and Kulpsville.

SIOUX FALLS, S. D.—For the third time Judge Jones, of this city, in the suit between the City of Bridgewater and the Bridgewater Telephone Company, has decided in favor of the company and against the town. His decision places all the costs and damages amounting to over $1,000, on the town, and gives the company the right to go ahead and establish its system if it so desires.

MEMPHIS, TENN.—The Citizens' Telephone Company has been organized at McMinnville, Tenn. Orders have been placed for poles, and other necessary materials for constructing the plant and lines of the company and work will be pushed as rapidly as possible. Already more than 100 patrons of the Cumberland Telephone & Telegraph Company have signified their intention of using the lines of the independent concern.

DENTON, TEXAS.—The City Council has granted to W. A. Armstrong, of Sherman, a franchise to install another telephone exchange in this city.

SPOKANE, WASH.—It is announced that the Pacific States Telephone Company is planning to build a new line from Wenatchee to Malaga and Rock Island.

EAST TROY, WIS.—The farmers' telephone line now in operation has 110 subscribers connected.

GRAND RAPIDS, WIS.—The Wood County Telephone Company has increased its capital stock from $10,000 to $18,000.

WAUKESHA, WIS.—The Bell Telephone Company is arranging to give the city of Waukesha better telephone service. The lines are to be entirely rebuilt.

ELECTRIC LIGHT AND POWER.

SAN FRANCISCO, CALIF.—The Standard Electric Company, of California, recently won a suit for right of way for its long-distance transmission pole line from Blue Lakes to San Francisco. It fixed the damages for passing through the Corbitt ranch at Burlingame at $400. But one more suit will have to be decided to give entrance to San Francisco.

SAN FRANCISCO, CALIF.—Reno, Nevada, is now connected with the Truckee River General Electric Company's transmission lines. Both Virginia City and Reno are now lighted by this company, which is now able to pay dividends without depending upon the business of the Comstock Lode, although the mines of that district gave a bonus of $100,000 to secure the plant.

SAN FRANCISCO, CALIF.—Santa Rosa now receives electricity for lighting and power purposes from the transmission lines of the Bay Counties Power Company. An all-night street lighting service is now in operation. The California Gas & Electric Company, which distributes the current locally, also controls the local gas plant and is rebuilding it. A pipe line 16 miles in length will be laid to convey gas to Petaluma for lighting purposes.

CHICAGO, ILL.—The Litchfield Electric Light & Power Company, of Litchfield, has changed its name to Litchfield Gas & Electric Company, and its capital stock has been increased from $25,000 to $50,000.

ALTON, ILL.—A petition is being circulated for signatures calling on the City Council to pass an ordinance regulating the maximum price to be charged for electricity for illuminating purposes. The Alton Railway, Gas & Electric Company has the franchise for serving gas and electric light, and it is claimed by the company that it is operating under a franchise that will admit of no regulations being made for some time to come. The matter of regulating the electric light prices has not been looked into. It is alleged that the prices charged are unreasonable.

INDIANAPOLIS, IND.—The Merchants' Light & Power Company has been organized here. The company has asked the Board of Public Works for a franchise.

UNION CITY, IND.—An effort is being made by H. P. Lucas, owner of the electric plant here, to induce the City Council to extend his franchise, promising a first class plant if they will. The load at present is entirely too heavy for the present plant.

INDIANAPOLIS, IND.—The State authorities have concluded to build a plant to furnish heat, water, light and power for the State House and Soldier's Monument in this city. The cost of the proposed plant will exceed $100,000. The Legislature will be asked for an appropriation.

LAWRENCEBURG, IND.—The new electric light plant is now in operation. The company, which was incorporated by John N. Fox, T. J. McKim and W. T. Sortwell, has a 30-year franchise and a ten-year contract to furnish the city 63 arc lights of 2000 nominal candle-power at $48.25 each per year. The company also provides commercial lighting.

INDIANAPOLIS, IND.—The Board of Public Works is receiving numerous petitions for franchises for electric light and power plants. The petitioners are groups of merchants who propose to erect plants to supply light, heat and power to their buildings. In some instances the petitions include the same, or parts of the same territory, and the competition is growing spirited. The Board has not acted on the petitions, as it has not yet decided on its policy as to franchises for light and power companies, and is unwilling to grant such franchises indiscriminately.

VAN HORNE, IA.—Mr. J. A. Wicke is putting in an electric light plant and is receiving bids for first and second-hand apparatus, consisting of a 30 to 40-hp engine, 30 to 50-hp boiler and a generator of 600 lamps of 16-cp capacity. He wants to get the plant running in 60 days.

LEAVENWORTH, KAN.—The Leavenworth gas and electric light plants have been purchased by S. Reading Bertron and Richard S. Storrs, both of New York. The price paid was $250,000.

NEWBERN, N. C.—The electric light bonds issued by the city have been sold to F. M. Stafford & Company, of Chattanooga, Tenn., at 108½.

STATESVILLE, N. C.—The electric light plant at this place was partially destroyed by fire; loss estimated between $2,500 and $3,000. Dynamos, switchboard, etc., were ruined.

GLENS FALLS, N. Y.—In regard to the rumor that the General Electric Company had purchased the Palmer Mills plant of the International Paper Company, on the Hudson River above Glens Falls, for the power privileges, it is authoritatively stated that the General Electric Company has made no such purchase, nor has it any intention of so doing.

HUBBARD, OHIO.—The citizens of Hubbard are agitating for a lighting plant of some kind. The town has been without illumination for several months.

OTTAWA, ONT.—It is reported that a company will build conduits for the electric light and power companies in Montreal. Senator Forget's idea is that the city should control the conduits and provide the means for their construction, charging the companies a rental.

OTTAWA, ONT.—The Canadian Niagara Falls Power Company has acquired some 300 acres back of the high bluff at Niagara Falls. The property will be used for factory and industrial sites. The same plan is to be carried out on the Canadian side as has been adopted on the American side of the river, which is to provide sites and power for any company desiring to locate there.

OTTAWA, ONT.—The directors of the Lachine Hydraulic & Land Company have declared a semi-annual dividend of 3½ per cent. This makes the sixth semi-annual dividend declared by this company, the first being 2 per cent. It is said that the company might have easily made the present dividend declared for 4 per cent., or even more, but deemed it best to declare only 3½ for the half-year.

OTTAWA, ONT.—It is reported that the Chambly Manufacturing Company, of Montreal, is about to acquire the Lachine Hydraulic & Land Company, at a cost of $4,000,000. The Chambly Company is already under the control of the Montreal Light, Heat & Power Company, and this deal will give the Power Company a practical monopoly in Montreal, unless new opposition should be forthcoming. Since the organization of the latter concern, with its $17,000,000 capitalization, less than a year ago, it has absorbed all the lighting and power concerns doing business in the city of Montreal, except the Lachine Hydraulic Company. Negotiations have been under way for some time, looking to the purchase of that company. The power combine will not be the direct purchaser of the Lachine Company's plant. It will pass into the hands of the Montreal & St. Lawrence Light & Power Company, formerly known as the Chambly Manufacturing Company, which recently obtained authority to change its name and issue bonds.

ANDERSON, S. C.—On the night of Dec. 20 part of the dam of the Anderson Water, Light & Power Company was washed away and the damage is estimated at $100,000. The dam was 700 feet long, 44 feet high, and 30 feet wide at the base. About 150 feet is missing in the centre. It is estimated that the cost of repairing will not be less than $60,000. In the meanwhile, many industries in the city of Anderson will be compelled to remain idle.

ELIZABETHTON, TENN.—Col. Chas. Toncray and Geo. E. Boren have returned from New York, where they have been closing negotiations for the erection of a modern steel plant at Elizabeth. An 8000 horse-power electric plant will be erected as soon as a location is decided upon.

EVANSVILLE, WIS.—The city contemplates erecting a $51,000 electric light and waterworks plant.

THE ELECTRIC RAILWAY.

SAN FRANCISCO, CALIF.—It is reported on good authority that the Oakland Transit Company has almost completed negotiations for the remaining half interest in the Macdonald and Henshaw franchise for an electric road from Martinez, via Richmond, to Oakland, Calif.

SAN FRANCISCO, CALIF.—The Oakland Transit Company will construct an additional electric railway line giving North Berkeley, Calif., connection with the company's system. The new road will be in the form of a loop, running north of the grounds of the University of California and connecting with the West Berkeley lines.

SAN FRANCISCO, CALIF.—The latest report on the prospective sale of the North Pacific Coast Railway, which terminates in Sausalito, Calif., is that the price has been set at $2,000,000, or about one-half the cost of the road. It is the intention of Messrs. Childs, Colgate and Martin, of the new California Electric Company, to extend the road to Sacramento and operate it by electricity. The deal my be consummated on Jan. 15.

ATLANTA, GA.—The Georgia Railway & Electric Company has applied for a charter; capital stock, $3,000,000. H. M. Atkinson and others are interested.

SAVANNAH, GA.—The Savannah Electric Company has been chartered, with a capital stock of $3,500,000, consolidating all of the street car lines in Savannah. Geo. Baldwin, J. R. Anderson and others are interested.

INDIANAPOLIS, IND.—The Commissioners of this county have granted a franchise to M. D. Whitney and others to build and operate an interurban railway line from the city limits northeast to the county line, along the Pleasant Run road.

WABASH, IND.—Messrs. Drake, Breed & Company, of Philadelphia, have taken the contract to build a 20-mile stretch of interurban electric railway connecting this city with Marion, beginning work early in the spring. The promoters are G. A. H. Shiedler, R. E. Breed and C. S. King. The contractors have made a careful inspection of the route and say Philadelphia capital has been provided to construct the line. Terminal rights are now being arranged at Marion and this city.

MOUNT STERLING, KY.—The Lexington Electric Railway Company has been granted the right of way from Winchester to Mt. Sterling. The line may also be extended to Maysville from Mt. Sterling.

LOUISVILLE, KY.—President T. J. Minary, of the Louisville Street Railway Company, has addressed a letter to the Mayor outlining the plans of the company. The company will purchase for delivery during 1902 from 75 to 100 electric cars. A new engine and generator have been installed representing a heavy expenditure. The lines of the company have also been extended, representing an outlay of $105,000.

DETROIT, MICH.—There is talk that the Everett-Moore syndicate will extend its Detroit-Pontiac line to Lansing by way of Milford, Howell, and Williamson.

MINNEAPOLIS, MINN.—An electric railway line between Mankato and St. Cloud is projected, the distance between the two points being about 100 miles. Col. Chase, of Cleveland, Ohio, is promoting the enterprise.

SUMMIT, MISS.—The electric railway between this town, McComb and Magnolia in Pike County, is still being agitated, and is now said to be assuming something like tangible shape.

ELIZABETH CITY, N. C.—A charter has been granted and the company incorporated to build the proposed electric railway to Norfolk, Va.

TRENTON, N. J.—Mayor Briggs vetoed the ordinances giving the Camden & Trenton Traction Company authority to extend its lines into the centre of the city of Trenton. The ordinances will probably be passed over the Mayor's veto.

SCHENECTADY, N. Y.—The Schenectady Railway Company, of Schenectady, has filed a certificate of increase of capital from $300,000 to $600,000.

SYDNEY, N. S.—The Cape Breton Electric Company, of Sydney, N. S., is about to commence the erection of a new power house. Engines of 1000 horsepower will be installed at the outset.

TROY, OHIO.—Work has commenced on acquiring right of way for the Dayton-Kenton electric railway.

WOODVILLE, OHIO.—The Lake Shore Electric Railway has applied for a franchise to double track its line through the town.

DOYLESTOWN, OHIO.—The Doylestown Council has granted a franchise through town to the Canton, Lodi & Medina Electric Railway.

FINDLAY, OHIO.—The Findlay & Marion Railway Company, which is promoted by Hon. David Joy and others, has applied for a franchise in Findlay.

DAYTON, OHIO.—The Dayton & Northern Traction Company is making preparations to extend its road to Muncie, Ind. Right of way is being secured.

HAMILTON, OHIO.—The Miamisburg & Germantown Traction Company has issued $50,000 in bonds which have been taken by the Cincinnati Trust Company.

AKRON, OHIO.—The annual meeting of the stockholders of the Northern Ohio Traction Company will be held Jan. 18. It is stated that a number of important changes will be made.

ATHENS, OHIO.—It is stated that the promoters of the Athens & Nelsonville Traction Company will carry out their long-talked-about project of a line from Athens to Nelsonville and other places.

DAYTON, OHIO.—The Dayton & Xenia Transit Company, controlling the two lines between Dayton and Xenia, has issued $800,000 in bonds, which have been taken by the Old Colony Trust Company.

SPRINGFIELD, OHIO.—Harry Frey has secured a street railway franchise through Greene County from Clifton to Xenia. The line will be a spur of the road he proposes to build from Springfield to Wilmington.

SPRINGFIELD, OHIO.—The Dayton, Springfield & Urbana Railway is reported to be buying up all the cordwood in sight, as it is almost impossible to secure enough coal to keep the power house in operation.

CONNEAUT, OHIO.—The Conneaut & Erie Traction Company, of which J. S. Van Cleve is president, and H. E. Fish, secretary, has secured nearly all of the right of way for its proposed line from Conneaut to Erie.

WILMINGTON, OHIO.—Franchises are being secured for the proposed electric railway from Springfield to Hillsboro. Right of way has been secured through Greene County. The road is to be built in the spring.

PIQUA, OHIO.—A new line is proposed from Springfield to this place, passing through Lawrenceville, North Hampton, Dilton, Addison, and Casstown. The company already has right of way from Springfield to Addison.

TOLEDO, OHIO.—The Tiffin & Southern Railway Company has placed a contract with the Pennsylvania Contracting Company for the construction and equipment of the road from Tiffin to Kenton, a distance of 43 miles.

ASHTABULA, OHIO.—The Ashtabula Rapid Transit Company has made a proposition for a franchise covering existing lines and proposed extensions. The company agrees to pay a portion of its gross receipts to the city.

MARIETTA, OHIO.—The Marietta Electric Railway Company has formally transferred its property to the Marietta & Parkersburg Interurban Company. The Marietta-Parkersburg line will be placed in operation within a short time.

GALION, OHIO.—The Ohio Central Traction Company commenced regular service Christmas day between Galion and Crestline. Cars are now operated from Bucyrus to Crestline. Work on the line between Crestline and Mansfield is being pushed.

SMITHFIELD, OHIO.—Local people are securing right of way for a line to extend from Adena through Smithfield, Dillonvale, Harriettville and Mt. Pleasant to Warrenton, where it would connect with the line between Steubenville and Wheeling.

NORWALK, OHIO.—The Norwalk, Greenwich & Mansfield Railway Company will shortly be organized. M. J. Roseboro, of Canton, and J. C. Laser, of Mansfield, are the promoters, and they claim to have secured nearly all right of way and franchises.

FINDLAY, OHIO.—Dr. O'enbaugh, of Sandusky, one of the promoters of the Findlay & Southern Railway, claims that all right of way for the road has been secured and that construction work will start in the spring. R. Rosenstock & Company, Cleveland, are engineers for the road.

SPRINGFIELD, OHIO.—The scarcity of coal is proving a serious embarrassment to power-houses in Springfield and Dayton. The Dayton, Springfield & Urbana power-house burned wood part of the time recently, and several times there was danger that the road would be tied up.

YOUNGSTOWN, OHIO.—The Youngstown Park & Falls Electric Railway has declared a semi-annual dividend of 3 per cent., the highest ever paid. The old officers were re-elected. An appropriation of $15,000 was made to improve Idora Park, and other improvements were discussed.

LIMA, OHIO.—D. J. Cable, president of the Lima, Delphos, Van Wert & Ft. Wayne Traction Company, states that all right of way for the line has been secured, and that engineers will commence surveys within the next two weeks. The line will be 60 miles in length, and it is claimed it will be in operation by Dec. 1, 1902.

NEWARK, OHIO.—It is stated that L. C. Taylor and John S. Black, promoters of the line between Newark and Wheeling, have secured all the required right of way, and that they have completed arrangements with New York financiers to finance the project. The road if built will give Columbus direct electric connection with Wheeling.

TOLEDO, OHIO.—C. A. Denman, heretofore general manager of the Toledo & Maumee Valley Railway, which has just been sold by the Detwiler-Griffin syndicate, has been appointed to a similar position with the Toledo & Lima Traction Company, a road being built by the same syndicate. Mr. Denman is one of the pioneer street railway men of Toledo.

UPPER SANDUSKY, OHIO.—It is stated that the Tiffin & Southern Railway Company, which has recently secured Eastern financial backing and has placed a contract for the immediate construction of the road, has acquired the right of way and franchise secured last year by the Tiffin & Southwestern Railway, which was promoted by Samuel Bullock and others of Tiffin. The road will be built over the route proposed by the Bullock Company, extending from Tiffin to Kenton by way of Upper Sandusky, McCutchenville and Marseilles.

TOLEDO, OHIO.—The Everett-Moore syndicate has closed the deal for the purchase of the Toledo & Maumee Valley Railway and the Toledo, Waterville & Southern Railway. Immediately after the transfer of the properties, special meetings were held and officers of the companies were elected as follows: Toledo & Maumee Valley Railway: R. H. Baker, president; William H. McLellan, Jr., secretary; Barton Smith, Guy M. Walker, William R. Hodge, and Conrad Weil, directors. Toledo, Waterville & Southern Railway: Ernest J. Bechtel, president; W. W. Brown, secretary; C. N. Jackson, Guy M. Walker, Charles T. Munz and Josiah Scott, directors. L. E. Beilstein, of the Toledo Railways & Light Company, was made general manager of both properties.

OTTAWA, ONT.—The franchise of the South Essex Electric Railway Company, of Windsor, Ont., has been purchased by the Everett-Moore Company, of Cleveland, Ohio. The charter and franchise extend from the city of Windsor to Point Pelee and Leamington.

ROSEBURG, ORE.—An electric railway between here and the coast would be well patronized, and there is a good field for such an enterprise.

NORRISTOWN, PA.—The Trappe & Limerick Electric Railway and the Roxborough, Chestnut Hill & Norristown Railway have been leased to the Schuylkill Valley Traction Company for 950 years. This combines all the lines heretofore operated under the several names, with a centre of operations here. The new power house at Collegeville will furnish power for the entire line, from Pottstown to Chestnut Hill, Manayunk and Wissahickon.

PITTSBURG, PA.—The Philadelphia company of this city on Jan. 1 absorbed all the street railway and electric lighting interests in and about Pittsburg. The interests which have been amalgamated are the Consolidated Traction, Pittsburg and Birmingham, Monongahela Street Railway, Pittsburg & Charleroi, Suburban Traction, Southern Traction, Tustin Street Railway, Monongahela Heat, Light & Power, Southern Heat, Light & Power Company, and a number of other electric traction or lighting companies of minor importance. The bonded indebtedness has been increased from $6,500,000 to $22,000,000, and the capital stock from $21,000,000 to $36,000,000. The Philadelphia company forms one of the largest corporations in the electrical business of this country. Mr. James D. Callery is the president and Mr. John Murphy, the general superintendent.

KNOXVILLE, TENN.—The promoters of the electric railway from Knoxville to Sevierville, it is said, have about decided to make the line a third-rail system.

MANITOWOC, WIS.—The Manitowoc-Two Rivers interurban electric road now being constructed, will soon be opened for business.

MILWAUKEE, WIS.—The Columbia Construction Company of this city, has charge of the construction of the electric railway to be built between Fond du Lac and Oshkosh. The line will cost about $12,000 a mile, or $144,000 for the entire system.

OSHKOSH, WIS.—The proposed Ouiro-Oshkosh electric railway seems practically assured. The franchises have all been secured between Ouiro and Oshkosh. The line will be constructed to carry passengers, express, mail and freight. The proposed line will be extended through Eureka to Berlin in time, and may eventually follow the Fox River Valley through to Portage, connecting there with the proposed lines to Madison, Janesville and the Wisconsin River points.

NEW INDUSTRIAL COMPANIES.

THE ELECTRICAL ACCESSORIES COMPANY, of New York City, has been incorporated with a capital stock of $50,000.

THE NORTH BRADDOCK ELECTRIC COMPANY, of North Braddock, capital $1,200, has been incorporated at Harrisburg, Pa.

THE RANKIN ELECTRIC COMPANY, Rankin, Pa., has been incorporated; capital, $1,200.

THE PHOENIX GAS & ELECTRIC FIXTURE MANUFACTURING COMPANY has been incorporated at St. Louis, Mo. The capital stock is $15,000, all paid. A. D. Gratian, Chas. M. Wempner, Maurice W. Koenigsberg and Frank X. Chassaing are the stockholders.

THE GREEN TELEPHONE & ELECTRIC MANUFACTURING COMPANY, recently incorporated in Milwaukee, Wis., by J. H. Green, T. J. Seely and Chas. Hemsing, is manufacturing a line of telephone apparatus containing some new ideas. The company, it is said, has a new transmitter and a novel scheme in an automatic intercommunicating switchboard.

LEGAL.

GLAZE FILLED INSULATOR PATENT.—Note has already been made in these pages of patent decisions in favor of the glazed filled insulator patent of Mr. John W. Boch, of the R. Thomas & Sons Company. The last action in the affair is a supplementary opinion from the United States Circuit Court of New Jersey, against the defendant's plea for reargument, and sustaining Boch as follows: "Boch has conceived and perfected that which others had striven for in vain. Characterized in a phrase, his invention may be spoken of as a glaze-filled multi-part porcelain insulator. Its particular features have already been adverted to. The process he employs and has patented seems peculiarly fitted to accomplish the end desired, but the fact that there may be others, does not debar him from laying claim to the result attained, of which he seems to be the discoverer."

PERSONAL.

MR. GODFREY MORGAN, formerly general manager of the Niagara Gorge Railway, has been appointed general superintendent of the Youngstown & Sharon (Ohio) Electric Railway.

MR. WALTER C. ALLEN, the electrical engineer to the Commissioners for the District of Columbia, has just issued through them the annual report of the work done and supervised in Washington. It constitutes a very interesting and instructive document.

MR. T. AHEARN, president of the Ottawa, Can., Electric Company, which controls the lighting and street railway systems, has started off with his family for the Mediterranean. The Ahearns are great globe trotters, and are not long at home from a trip around the world.

MR. GEORGE F. PORTER, secretary of the National Electric Light Association, returned last week from Alaska, where he had been for some three months for the purpose of superintending the laying of the submarine cable between Skagway and Juneau, the contract for which was secured by his firm.

MR. EDWARD HEITMANN contributed to our pages last year an interesting serial on the inductor alternator. We are glad to note that the articles have now been reprinted in a bulletin by the Stanley Electric Manufacturing Company, with whose engineering staff he is associated.

MR. HENRY C. PAYNE, the new Postmaster-General, will, it is said, resign his position as vice-president of the Milwaukee Electric Railway & Light Company, at the annual meeting in February. It is understood, however, that he will retain all his interests in that and other enterprises, such as the Wisconsin Telephone Company, with which he is much less actively connected.

MR. D. F. HENRY, vice-president of the Central District Printing & Telegraph Company, Pittsburg, which is the local branch of the Bell Telephone Company, has resigned his position on account of the great demand made upon his time by his many other business interests. Mr. Henry is considered the father of the telephone in Pittsburg, as he introduced and installed the first one there in 1878.

LIEUT. COMMANDER B. A. FISKE, U. S. N., well known for his electrical work, has just contributed to the *United Service* a most charming narrative of his share in, and observations made during, the famous battle of Manila, when he served as navigating officer of the U. S. S. "Petrel," under Dewey's orders. Commander Fiske is not only modest, but cool, and his notes show that all through the fight his sub-consciousness was also working at full efficiency.

DR. S. S. WHEELER, president of the Crocker-Wheeler Company, of Ampere, N. J., is the subject of a biographical sketch in *Cassier's Magazine* for January. The article is written with insight and appreciation, and does justice to Dr. Wheeler's technical work, while bringing out what is not so generally known, his skill in directing and organizing shop management and accounts. Reference is made to his recent gift of the Clark Library to the American Institute of Electrical Engineers, and a fine portrait accompanies the article as frontispiece to the magazine.

MR. CHAS. S. DRUMMOND, of the Electric Traction Company of England, is visiting this country. The *New York Times* tells the following story of him: "Mr. Drummond arrived from London a couple of weeks ago and started for British Columbia. On the way he met with a railroad accident. As usual, the serious situation was not without its comedy. As the car in which Mr. Drummond was sleeping heeled over and rested upon its side, and Mr. Drummond was clinging to the edge of his berth, he heard a feminine voice from out the depths of the opposite berth—which was now below him, say: 'Please, Mr. Drummond, won't you take off mother? She is dreadfully heavy.'"

Trade Notes.

THE H. E. LINDSEY ELECTRICAL COMPANY, of St. Louis, Mo., has increased its capital stock from $5,000 to $10,000.

THE MICHIGAN CARBON WORKS, Detroit, Mich., has been licensed to do business in Illinois; capital stock, $600,000; capital in Illinois, $2,500.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has brought out a special loud-ringing extension telephone bell, which is just what is needed for noisy places.

FIRE DAMAGE.—The College City Electric Company, Galesburg, Ill., manufacturer of automatic time switches, suffered a disastrous fire on Dec. 11, but by two days before Christmas it succeeded in getting back to its office.

BULLOCK CALENDARS.—The Bullock Electric Manufacturing Company's calendar for January, 1902, contains a vignette portrait of Benjamin Franklin. This is the first one of the series containing pictures of great men of science and engineering.

SUPPLY HOUSE IN MANILA.—Messrs. Mellinger & Landon, electrical engineers and contractors, Manila, P. I., have opened an electrical supply house in that city and are arranging to execute electrical work in all parts of the islands.

THE FORT WAYNE ELECTRIC WORKS has, through its Cincinnati office, just sold to the village of Madisonville one 100-kw alternator and one 125-light arc machine for installation in the new power and lighting plant. The Tudor Boiler Works, of Cincinnati, furnished the boiler equipment.

RELIANCE BULLETINS.—The Reliance Electric Company, Milwaukee, Wis., has issued three bulletins devoted to direct-current multipolar dynamos and motors for lighting and power, and motors especially adapted for crane, bridge, pumps and elevator work. They are illustrated, and briefly point out the features of these machines.

FORGES.—The B. F. Sturtevant Company, Boston, Mass., has issued a pamphlet on its small forges, various styles of which are illustrated. These forges are designed for every use where portable forges are desired, and one is fitted with electric blower. The principal dimensions of the different sizes of each style, and a price list are also given.

ELECTRIC AND STEAM HOISTS.—The C. W. Hunt Company has just issued a pamphlet on electric hoists of the type described and illustrated in our last issue. The pamphlet is fully illustrated. A catalogue has also been issued by the same company describing and illustrating its line of steam hoisting engines. Copies of the above can be obtained on application.

ARTISTIC CALENDAR.—The twentieth century calendar of N. W. Ayer & Son, Philadelphia, Pa., keeps up its high artistic merit, and this year's is better than that of last year. The background and main sheet is a work of art, which is enhanced by some tasteful color work by the printer. Messrs. Ayer & Son charge 25 cents for these calendars, to cover the cost of their production, handling, etc.

GENERAL ELECTRIC BULLETINS.—Bulletins 4267, 4268, 4269, 4270 of the General Electric Company have for their respective subjects: Low-voltage arc lamps, Brush arc generators, direct-driven revolving-field alternators for electric lighting, and feeder regulators. In each case the apparatus is excellently illustrated, diagrams of the connections and circuits being given where necessary.

SILENT DRIVING CHAIN.—"Renold High Speed Silent Driving Chain" is the title of pamphlet No. 203 (32 pages) issued by the Link-Belt Engineering Company of Nicetown, Philadelphia, descriptive of this new device for transmitting power. It appears from a perusal of the booklet that the silent drive is supplanting other means of transmission in many places, and that almost as soon as its properties are comprehended, engineers suggest innumerable applications for its use.

A NEW YEAR'S CHECK.—The American Electrical Heater Company, of Detroit, Mich., has done so well last year that it is remembering its friends by sending them a "check" upon the "National Bank of Prosperity" for 365 "prosperous days." If the prosperity called for is realized the American Electrical Heater Company will have good reason to feel satisfied with the investment. The check is signed by B. H. Scranton, president, and countersigned by John Scudder, secretary-treasurer. The idea is a capital one.

THE GEORGE F. BRUNT PORCELAIN WORKS, East Liverpool, Ohio, are to be congratulated on the very charming souvenir which is being sent out under their name. It is in the form of a large calendar, which surrounds a most pleasing portraiture of Shakespeare's Ophelia. The coloring is very beautiful. The artist has shown Ophelia in a character of gentleness, and has succeeded in producing an excellent piece of work, which the George F. Brunt Porcelain Works have honored themselves in presenting to their friends.

DECENNIAL OF CORRESPONDENCE SCHOOLS.—Many worthy and ambitious young men have received valuable assistance through correspondence schools in their endeavor to attain better positions in their chosen vocations, and the standing of some of these schools has been recognized by leading educators. This system of teaching has just closed its tenth year of existence in Scranton, Pa., where the International Correspondence Schools are located. These schools began on Oct. 16, 1891, when the first student was enrolled. They began in a limited way under the name of "Correspondence School of Mines," and since that time the idea has been extended in its application to embrace many of the professions and trades, and thousands of scholars have been materially benefited by the instruction received in this way. The International Correspondence Schools was, some months ago, awarded a diploma and silver medal by the Philadelphia Export Exposition, through the Franklin Institute, for "a unique, thorough and comprehensive system of technical education by correspondence." The history of the growth of these schools is full of interest to any one who has ever given a thought to the subject of education.

Record of Electrical Patents

UNITED STATES PATENTS, ISSUED DEC. 31, 1901.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

689,849. APPARATUS FOR DETECTING AND LOCATING METALLIC ORES, MINERALS, ETC.; F. H. Brown, Chicago, Ill. App. filed Jan. 24, 1900.

689,877. ELECTRICAL CONDUCTOR AND ANODE; L. Hargreaves and W. Stubbs, Farnworth in Widnes, England. App. filed June 17, 1899. The head of the anode is sealed into the bottom of a pan which contains oil to prevent disintegration at the junction between the anode and its conductor.

689,889. TRANSMITTER; O. L. Kleber, Pittsburg, Pa. App. filed Sept. 10, 1900.

689,894. ELBOW FOR CONDUITS FOR ELECTRIC WIRES; G. A. Lutz, Brooklyn, N. Y. App. filed May 23, 1901. The elbow is provided with a hinged joint so that the conduit can assume any angle.

689,929. CONTROLLING DEVICE FOR CONNECTING STORAGE BATTERIES WITH CHARGING LINES; N. H. Suren, Needham, Mass. App. filed June 19, 1899. A polarized relay inserted between the charging circuit and battery automatically opens the circuit in case the polarity of the charging current is not suited for charging.

689,930. APPARATUS FOR CONTROLLING THE CONNECTION OF STORAGE BATTERIES WITH CHARGING CIRCUITS; N. H. Suren, Needham, Mass. App. filed June 29, 1899. A modification of the preceding invention in which a cut-out magnet is used to automatically open the circuit when the voltage of the charging current is too low or the counter current of the battery too high.

689,937. COMBINED FLEXIBLE CONDUCTOR AND RESISTANCE CORD; E. E. Werner, Indianapolis, Ind. App. filed Aug. 13, 1900. A resistance conductor is incorporated with the main conductor in a flexible cord.

689,947. ADVERTISING DEVICE; E. M. Bantley, Lawrence, N. Y. App. filed Jan. 19, 1897. A slow-acting circuit closer is attached to a trolley wire so that as each car passes, a circuit to an advertising device along the roadway will be closed, and the advertisement for a short predetermined time displayed.

689,959. PROCESS OF DISINTEGRATING AND COMMINUTING MINERALS OR ORES; E. L. Graham, Upper Warlingham, Eng. App. filed March 26, 1901.

689,975. RAILWAY SIGNALING APPARATUS; F. A. Landee, Moline, Ill. App. filed Sept. 29, 1900. A signal actuating instrument adapted also to prevent the actuation of the signal under certain conditions.

689,976. RAILWAY SIGNALING APPARATUS; F. A. Landee, Moline, Ill. App. filed Sept. 29, 1900. As an improvement on patent No. 467,570, means are provided by which more than one signal placed at different railroad crossings can be operated simultaneously by a train approaching in either direction.

690,040. ELECTRIC FIRE ALARM; O. B. Thompson and W. G. Midgley, Buffalo, N. Y. App. filed Feb. 23, 1901. A circuit closer operated by the fusing of a soft metal.

690,048. PROCESS OF TREATING NATURAL PHOSPHATES; L. Cheeseman, Sr., Alexandria, Va. App. filed Feb. 16, 1901.

690,060. ALTERNATING INDUCTOR DYNAMO; J. Jacoby, Elizabeth, N. J. App. filed May 13, 1901. A drum fixed on the shaft and having an integral exterior flange out of center lengthwise of the drum and a laminated primary polar ring on the drum, the ring having polar projections and being fastened to the integral flange.

690,105. ELECTRIC ARC LAMP; J. H. Hallberg, New York, N. Y. App. filed April 25, 1901. An impedance coil is automatically thrown into a circuit around the lamp when the resistance of the arc exceeds a pre-determined amount.

690,108. ELECTRIC CONTROLLER; G. H. Hill, Glen Ridge, N. J. App. filed Aug. 5, 1901. A solenoid automatically cuts resistance out of its own circuit as its core moves inward to thereby afford uniformity in the force acting upon the plunger in its various positions; means are also provided to vary the value of the current in the solenoid in order to move or check the plunger at any position.

690,110. TROLLEY RETRACTOR; A. J. Johnson, Cleveland, Ohio. App. filed Oct. 12, 1901. Details.

690,141. CONTINUOUSLY ELECTROLYZING ALKALI CHLORIDS; W. Gintl, Aussegg, Austria-Hungary. App. filed Nov. 17, 1900. (See page 86.)

690,151. METHOD OF UTILIZING ELECTRICAL EARTH CURRENTS; E. Jahr, Berlin, Germany. App. filed July 24, 1900.

690,155. STAGE POCKET; J. I. C. King, New York, N. Y. App. filed Aug. 20, 1901. A pocket in the floor of a stage is provided with a hinged cover which in moving to its closed position closes electrical contacts for the branch circuit provided the plug has first been adjusted in position to be acted upon by the cover.

690,181. ELECTRIC ACCUMULATOR; A. Pouteaux and A. Wolff, Dijon, France. App. filed April 9, 1901. (See Current News and Notes.)

690,190. APPARATUS FOR TREATING GOLD ORES; Vicente Pazos y Sacio, Yauli, Peru. App. filed Nov. 8, 1900. (See page 86.)

690,219. ELECTRICAL EQUIPMENT OF RAILWAY VEHICLES FOR THE PURPOSE OF LIGHTING, HEATING, AND VENTILATION; A. Zehden, Charlottenburg, Germany. App. filed July 14, 1900. An arrangement of automatic switching devices for charging and discharging a battery and controlling a dynamo driven from the axle.

690,248. SYNCHRONIZING SYSTEM; W. Duane, Boulder, Colo. App. filed March 19, 1901. Motors at different stations coupled to sun-flower contacts, are maintained at uniform speed by utilizing variations in the speed between the motors at different stations, to cause such a change in the circuit of one or the other of the motors as will so far correct its movements as to bring the motors into synchronism with each other.

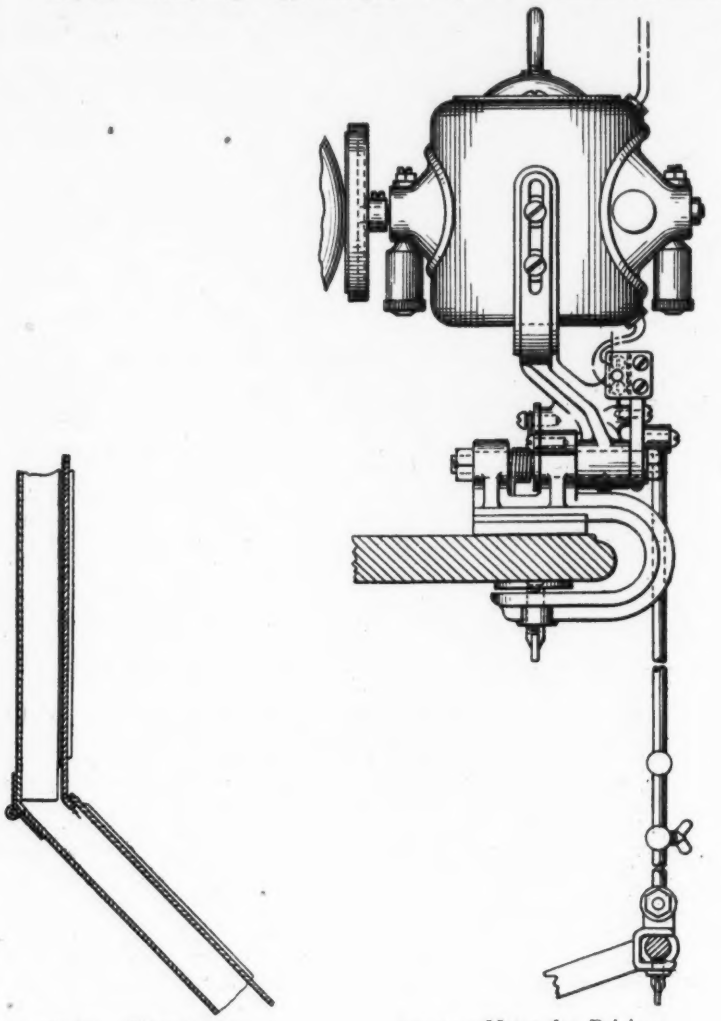
690,255. ELECTRIC SHIFTING DEVICE FOR RAILWAYS; H. S. Esch, New York, N. Y. App. filed April 26, 1901. Details of an electro-magnetically controlled railway switch.

690,256. AUTOMATIC TRACK SWITCH FOR ELECTRIC RAILWAYS; H. S. Esch, New York, N. Y. App. filed April 26, 1901. A construction affording a short insulated section in a trolley wire.

690,268. PRIMER FOR ORDNANCE; C. Von Gortz, Vienna, Austria. App. filed Sept. 28, 1900. The primer is constructed so that in case the electric firing devices fail, it can be fired by percussion.

690,282. ELECTRIC SIGNALING APPARATUS; F. B. Herzog and S. S. Wheeler, New York, N. Y. App. filed Jan. 25, 1886. A transmitter comprising a rheotome and a step by step escapement, a motor-spring, and a magnet, all co-operating to rotate the wheel as a result of the operation of the rheotome, and circuit controlling elements co-operating with the wheel to produce predetermined signals.

690,283. INSULATED ELECTRIC CABLE OR CONDUCTOR; G. E. Heyl-Dia, Manchester, Eng. App. filed July 11, 1900. A twin-wire conductor having a fillet of permeable material inserted centrally between the wires through which to drive nails to fasten the conductor in place.



689,894.—Elbow for conduits for Electric Wires.

690,334.—Motor for Driving Sewing Machines.

690,313. TROLLEY POLE ATTACHMENT; G. F. Nelson, Washington, D. C. App. filed May 16, 1901. Details.

690,319. PROCESS OF PRODUCING CARBIDS; I. L. Roberts, Brooklyn, N. Y. App. filed April 6, 1896. (See page 86.)

690,334. MOTOR FOR DRIVING SEWING MACHINES; H. R. Wellman, New York, N. Y. App. filed June 6, 1901. On the motor shaft is a friction disk which bears against the sewing machine wheel; the motor is pivotally mounted so that by means of a treadle it can be bodily moved to change the speed and stop and start the motor by changing the relative positions of the friction gear.

690,364. ELECTRIC SWITCH; J. J. Gaffney, Newark, N. J. App. filed March 2, 1901. A two-part spring, between the members of which a non-conducting rod is thrust to open one circuit and close another.

690,365. APPARATUS FOR THE CONTINUOUS ELECTROLYSIS OF ALKALI CHLORIDS; W. Gintl, Aussegg, Austria-Hungary. App. filed Oct. 10, 1900. (See page 86.)